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Twenty-eighth Convention
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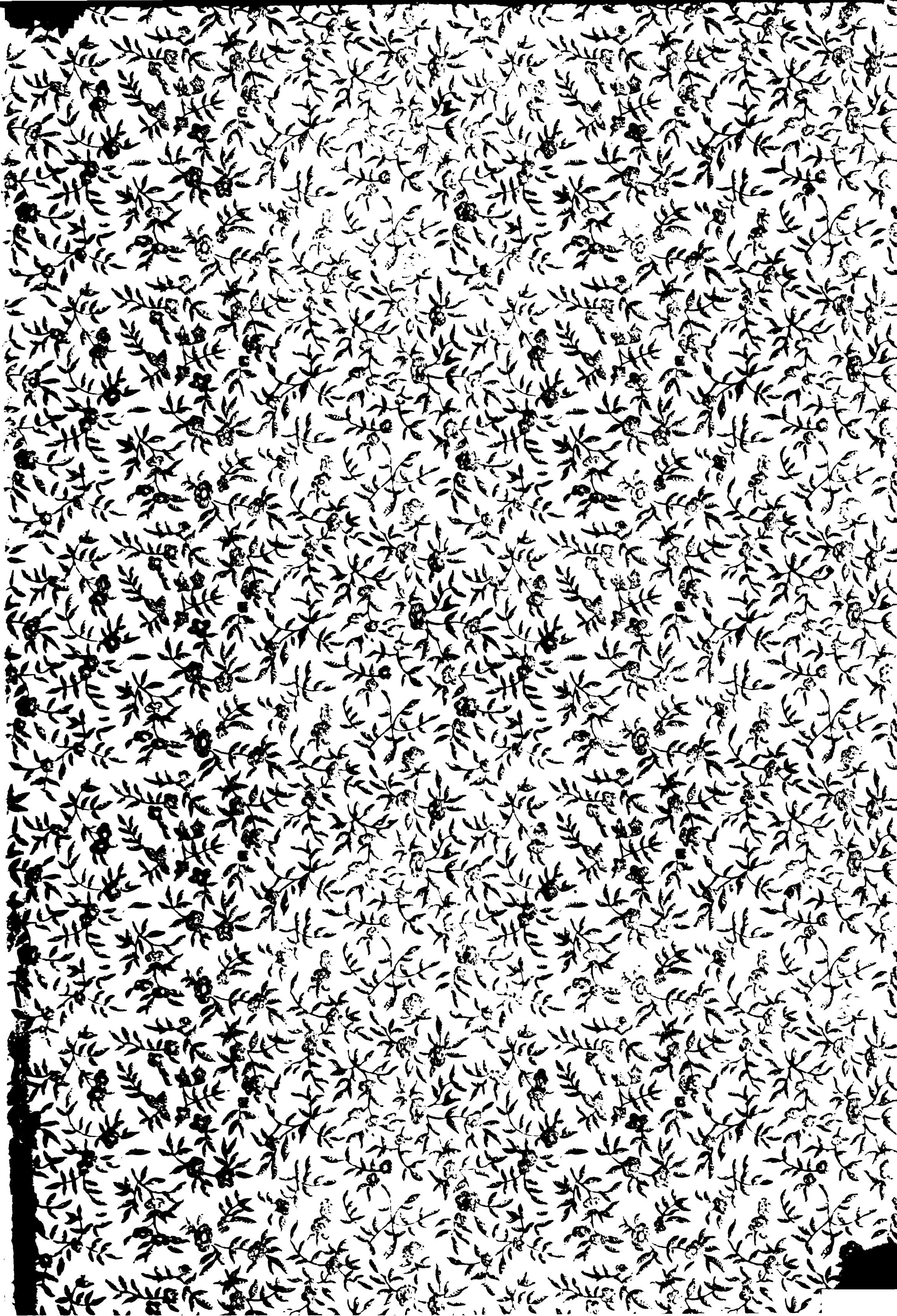

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A. E. Kennelly.

NATIONAL
Electric Light
ASSOCIATION

TWENTY-EIGHTH CONVENTION

VOLUME II
Question Box *and* Wrinkles

DENVER-COLORADO SPRINGS, COLO.
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Question Box

HOMER E. NIESZ, *Editor*

> "*A desire of knowledge is the natural feeling of mankind.*"
>
> —DR. SAMUEL JOHNSON

INTRODUCTION

I take pleasure in presenting to the association the fourth issue of the Question Box. *Its continued growth and constantly enlarging scope from year to year may properly be considered as indicative of its usefulness and popularity.*

The following figures illustrate the development of the Question Box:

Year	*No Headings*	*No. Questions*	*No. Contributors*	*No. Answers*
1902	..	*71*	..	*303*
1903	..	*193*	*125*	*682*
1904	*23*	*424*	*188*	*2178*
1905	*26*	*545*	*227*	*3057*

Herein is an incomparable medium for the exchange of ideas nurtured by study and ripened by experience—a forum where every man may be heard, no matter what his views or his position in the central-station industry may be.

Here is a source of information that is as valuable as it is unique in the literature of the art, for it contains not the opinions or conclusions of one man, but of many men and from as many points of view.

Many things in this Question Box *may appear trite and time-worn to some, but the differences of opinion that are expressed, the rapid changes in the technical and commercial phases of the business, and the requirements of the newer and younger members of the association, are sufficient reasons for the appearance and discussion of topics previously considered in earlier editions of the* Question Box *or in papers.*

The educational value of this volume is one of its important functions, and should be constantly borne in mind when considering its growth and development. The information given by one member is valuable to many, and in adding to the fund of knowledge he is enriching others at no cost to himself, as all are working along similar lines but in different places.

I wish to commend the practice, followed by some of the contributors of answers, of referring to some paper or publication which contains a full discussion of the points covered by *the question, and which is considered good authority on the subject. It is manifestly impossible to treat all the questions fully and comprehensively in this volume, and it is very desirable to supplement individual views by references when they can be found.*

The Question Box *has become well known to the members of this association during the preceding years of its existence, but during the current year it has introduced itself and the association to many electric-lighting companies not heretofore in touch with its work.*

Last fall a communication was sent out by the editor to all the electric-lighting companies, manufacturers, supply dealers, engineers, and technical schools of the United States and Canada, asking for a list of officers and leading men to whom Question Box *literature and other matter might be sent. The responses were very general, and, as a result, a mailing list of 7000 names was made up and used in sending out subsequent letters requesting both questions and answers. Many inquiries, regarding the* Question Box *and membership in the association, were received from the non-members addressed, and a number of applications for membership have been received. Thus enlarging the field of the* Question Box *has assisted in increasing the sphere of influence of the association.*

In conclusion I wish to extend my thanks to the many generous contributors to the 1905 Question Box *and to Miss Billings, the ever-willing and capable assistant secretary, for valuable assistance in this work.*

HOMER E. NIESZ.
Editor.

May 22, 1905.

Question Box

OF THE

Twenty-eighth Convention of the National Electric Light Association

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A

BUILDINGS

A 1. Does it pay to build brick or stone substations for mines and smelters?

Concrete makes by far the most desirable foundations for buildings and bridges. The cement must be the best Portland, more especially in low, damp ground. The building proper built of concrete will be much more enduring and solid than one of brick or stone. As examples of this, see recent constructions of dry docks, United States Navy Yard, Brooklyn, bridge foundations, walls, *et cætera*. W. W. TITZELL.

It pays to build brick or stone substations, inasmuch as it eliminates danger from fire. C. W. KOINER.

In my opinion, it pays to build brick, stone or concrete substations for any kind of power when it is justified by the revenue in sight. It not only makes permanent construction, but eliminates a great portion of the danger from fire; and fire is an element that all men in the power business abhor.

W. E. MOORE.

Substations should be built fireproof if the installation is large enough to warrant the first cost, especially in high-tension work. THE COLORADO SPRINGS ELEC. CO.

It pays to build stone or brick substations for mines and smelters if the contract for power is of long duration; but if the

contract is small and substations are not permanent, a good frame building will answer the purpose, although not fireproof.
H. N. CRANDALL.

A 2. What is the best floor construction for different types of central stations?

Concrete arches supported on steel floor beams, with a floor finish of encaustic tile or cement. W. F. SIMS.

Concrete for ground floor; arches of brick between steel I-beams for floors above, with covering of light concrete and cemented on top. W. W. TITZELL.

Steel construction reinforced with concrete, and top floor of tile. This is fireproof and easily kept clean as the oils, *et cætera,* will not penetrate and no dust arises from sweeping.
UNITED ELEC. LT. CO.

Concrete, or reinforced concrete, whenever possible.
W. E. MOORE.

Concrete is the best floor constructon for central stations.
H. N. CRANDALL.

All central stations should be equipped with fireproof floors which may be built of brick arches, terra cotta arches, or reinforced concrete arches. A good surface for either of the above is a granolithic finish which should be colored or tinted by the use of lamp black in the mixings so that the floor surface will not stain badly from oil or dirt. If a more finished floor surface is desired a terrazzo, such as is used in halls and corridors of office buildings, makes a very good finish, as also does a tiled floor laid with dark-colored tiles in small sizes.
I. E. MOULTROP.

Fireproof concrete or reinforced concrete.
AUGUSTA RY. AND ELEC. CO.

Concrete and cement, reinforced with half-inch round iron turned at an angle of 180 degrees at each end.
E. F. McCABE.

A 3. What kind of roof construction on brick engine-room is best; one that will not drop condensation on dynamos; one that will be fireproof?

Have found that slate roofing meets the requirements of this inquiry. W. B. ROLAND.

A form of construction that is extensively used, and answers the requirements, is composed of "book tile" and tee irons, supported by an appropriate steel structure. The top surface of the tile is plastered with cement mortar, so as to provide a smooth surface for a composition roof. W. F. SIMS.

Steel construction with cinder concrete and expanded metal. After the roof is on, the steel that is exposed should be well covered with asbestos. The top of the roof should be painted with waterproof paint and the inside with cold-water paint.
UNITED ELEC. LT. CO.

On our auxiliary plant we are using reworked corrugated iron for roofing. An air space of two inches under corrugated iron, then a layer of heavy roofing paper supported by galvanized-wire netting, two-inch mesh. W. E. MOORE.

We prefer a high-grade composition roof for station where same is flat, as it can be made tight and we have no trouble from condensation. We use the Carey roofing.
F. L. WILLIAMSON & CO.

A good construction for roof of the brick engine-room is a flat roof formed of book tile carried in light steel trusses, the top of the book tile being covered with a thin layer of concrete, five thicknesses of tarred paper mopped on with hot tar, and finished on top with building gravel spread over hot tar. The underside of the book tile should be plastered to give a smooth appearance, and a coat of paint on the plastering may be used or not as desired. If there are no monitors or skylights in the roof there should be no condensation allowed to collect on the roof. If the building is large and monitors are desired for light or ventilation, some condensation will collect on the monitor and usually this can be collected by gutters which will discharge back on to top of the roof. I. E. MOULTROP.

Asbestos lumber shield. AUGUSTA RY. AND ELEC. CO.

Slag roof on five-ply felt given all the pitch it will hold on 3-inch southern yellow pine, supported by 3-inch by 12-inch southern yellow pine purlins. E. F. MCCABE.

A 4. What kind of roofing is best for a station roof that is flat, but with sufficient pitch to allow water to run to conductor pipe?

What is commonly known as "tar and gravel" roofing has been found to give excellent results. This is composed of a roofing felt laid in four or five thicknesses, the roof and each layer being thoroughly mopped with a roofing composition, applied hot. The entire surface should then be mopped and covered with a layer of clean, screened gravel. The felt should be well flashed against walls and skylights, and then cap-flashed with galvanized iron or copper. W. F. SIMS.

See answer to question A 3.
F. L. WILLIAMSON & CO.

Considering the first cost and the cost of repairs, a tarred gravel roof is the best that can be used. It is also very easy to locate a leak on same and repair it when the roof gets old.
I. E. MOULTROP.

Slag roof laid as above. E. F. MCCABE.

We think the best covering for flat station roof is pitch and gravel. F. G. PROUTT.

A 5. What is the best fireproof and non-corroding covering for boiler-rooms?

See my answer to question A 3. W. E. MOORE.

See answer to question A 3.

F. L. WILLIAMSON & Co.

Concrete and cement. E. F. MCCABE.

A 6. Why does a tin roof pit and rust through near a water storage (hot) on the roof, while the rest remains good?

Because of sweating under the tin (between roof-boards and tin). Raise the tank so that air may circulate between roof and bottom of tank. CHARLES N. SHAW.

The tank prevents the sun from warming the tin and drying it off on the under side. C. E. BOWE.

The water of condensation on the surface of the tin absorbs sulphur from the surrounding atmosphere and makes diluted sulphuric acid, which readily finds its way through the thin coating of tin upon the steel plates of which sheet tin is made. When sheet tin used to be made by tinning heavy sheets of iron, by using the best Bancatin, few complaints of this kind were ever known. This is an age of steel, and it is well known that steel is more readily attacked than iron, particularly near salt water. W. W. TITZELL.

Probably sulphuric acid from coal dust.

AUGUSTA RY. AND ELEC. CO.

Pure hot water combines chemically with iron, while cold water, which contains lime or some other salt, forms a coating on the iron and thereafter has no further chemical effect. The district heating companies find that this chemical action is of such an extent that it is impracticable to return the water of condensation to the power-house. E. F. MCCABE.

A 7. Is the expenditure in hand-power cranes, and resulting expenditures in extra strength and height of walls, warranted in buildings for rotary-converter or motor-generator substations?

As a means of hastening repairs and thus insuring only short interruptions to the service in case of breakdowns, it is certainly a good investment; as a purely financial investment, it may or may not be, according to local conditions.

H. Bottomley.

The expenditure in cranes is not usually justified by preliminary calculations unless the units are of the 1000-kw size, or larger. Practice, as distinguished from preliminary calculations, shows that some equivalent for a crane is much more frequently needed in a station filled with small units than in a station equipped with a few large units. There is a compromise possible, which we have adopted to a limited extent, to wit: the installation of track and supports for a crane in each station, the span being always the same. There being a driveway into each station a truck can be backed in, the crane lowered from the track to the truck, hauled to another station and put into place there in about three hours. It results that one crane has served for installation in two of our substations and will probably serve in another within the year.

The Edison Ill'g Co. of Detroit.

Yes. E. F. McCabe.

The increase in expenditure involved in equipping a substation with traveling cranes depends so greatly upon the dimensions of the building and character of construction that would otherwise be employed as to make a general reply almost impossible. For ordinary stations employing converters or generators of less than 400 to 500-kw capacity, traveling cranes would hardly be necessary. If, however, new apparatus must be carried over apparatus in operation, a traveling crane would probably be economical. A. S. Kibbe.

The expenditure required for hand-power cranes means so little additional cost, so far as extra strength and height of walls of substation building is required, that I should think it would hardly be considered at all. A considerable portion of the cost of crane is saved in the initial installation of apparatus, and while accidents are rare with first-class modern apparatus, the importance of saving time when they do occur is far beyond a matter of saving a few dollars in the initial cost of station. It appears to me that this item should be considered as an investment for insurance purposes. H. T. HARTMAN.

It is hardly worth while to increase the cost of the rotary converter or motor-generator substation by the addition of a hand-power crane, for these machines are now being built in such a way that ordinary repairs can be readily made without the use of the crane. I. E. MOULTROP.

A 8. Is there any satisfactory battery-room floor material, other than vitrified tile or brick, in use? If so, what is the method used in laying?

We are using asphalt as the floor surface in a small battery room. It is laid on a concrete foundation in exactly the same manner as when laid for a street surface. It is satisfactory, to begin with, and we think ought to be permanently satisfactory. It was used in this instance to reduce the weight of the floor, the battery room being on an upper floor.

THE EDISON ILL'G CO. OF DETROIT.

Concrete floors with finishing coat containing only the necessary proportion of cement, properly graded to carry all the drippings promptly to sewer, are quite as satisfactory as any style of brick and highly preferable to some. Ornamental or accidental indentations in the surface of vitrified tile or brick, and the joints between tiles or bricks, will retard the flow of drippings to the sewer and even frequent flushing with water will not remove all of the acid. Sufficient water or dilute acid will remain to keep the floor almost constantly damp, and frequent alkaline washings are required to prevent leakage.

A. S. KIBBE.

Vitrified brick and tile are the most satisfactory material for a battery-room floor under general conditions. In the case of a small battery—such as an exciter battery, for example—and where there is not much excuse for getting acid on the floor, a concrete floor with a granolithic finish will make very good finish. Care should be taken to get a very good surface on the granolithic finish and it would be well to pitch the entire battery-room floor to drains so that it can be readily swept out in case water or acid is spilled on the floor.

I. E. Moultrop.

B

WATER-WHEELS, WATER-POWER, ETC.

B 1. Is there any remedy for anchor ice?

The best remedy for anchor and slush ice is to provide a large, quiet pond above the wheels, which will be permanently frozen over during the winter. With this condition no trouble will be had with either slush or anchor ice in the wheels.

Jas. B. Foote.

The most effective remedy is warmer weather. For open conduits I know of no remedy. W. E. Moore.

We have found that by using several boom logs in our still bay the water freezes over earlier than without, as the wind does not have the chance to break up the thin ice; we are never troubled with anchor ice after our still bay is frozen over. In the spring, when the ice has broken up, we have been very successful in keeping free from slush and anchor ice by putting brush in our canal; this catches the ice and allows a fair flow of water to come through. We also endeavor to keep the water as high as possible during the slush period and throw all possible ice over our waste weir, which is located above our bulkheads.

L. E. Watson.

The third winter of operation of our hydraulic station has been free from interruption by slush or cake ice, while during the first winter, though milder, we were obliged to give poor service and at times the station was shut down for several hours.

Our water supply is taken from the river and carried in an open ditch for three miles to the station. The current being swift, the ditch is lined with lumber to prevent washing of the banks. During the coldest weather we are obliged to take at least two-thirds of the water in the river; this leaves but little waste water at the river dam. We have arranged an overflow, running parallel with the current running into the head of the ditch. Just above this wasteway, we have three sheer booms, set at an angle to sheer the floating ice toward the wasteway. These booms are set about two hundred feet apart and one above the other, so that slush crowding under one is caught and sheered by the next boom below. With this arrangement the ice is thrown close enough to the wasteway to be caught by the surface current running over the wasteway. We make this wasteway as long as possible, allowing the water to flow over at a depth of about six inches. We find that we can handle more ice with this arrangement, and with less waste water than when the wasteway is narrow and deep. The water going into the ditch is nearly clear, so the slush forming in the ditch can be handled over a small wasteway at the station. The water splashing up on the sides of the flumed portion of the ditch causes a rim of ice to accumulate on the sides, reducing the capacity of the ditch and giving the anchor ice a chance to form in the still water under the rim. This ice is broken off during the day and wasted at the station overflow, leaving the ditch as clean as possible for the night's run.

During the first winter of operation ice would coat on the gates of our turbine water-wheels, choking the supply—so that at times the wheels would slow down to half speed or slower. We have been entirely free from this trouble the last two winters, thanks to a very simple remedy. When the gates show that they are beginning to stick, we turn on a jet of steam, from a 1.25-inch pipe, at about thirty pounds pressure. The pipes discharge into the supply water, about two feet above the wheel casing, directly over the gates. During the coldest weather we keep a slow fire, and only use the steam when we find it necessary. Once or twice we have had the ice start to stick on the wheels very unexpectedly, but have always obtained immediate relief upon raising the steam pressure to thirty or forty pounds. The steam will not only prevent the ice from sticking, but will help the water to cut it off after it has formed a thick coating.

HARRY D. POPE.

Have seen this partly overcome by placing heavy iron bars before the intake at an angle so that the ice would slide down the bars to the spillway. G. F. WILLARD.

Instead of seeking a remedy, would it not be better to try to stop the formation of it, and so have no need of a remedy? There are several methods of doing this, none of which, however, give absolute immunity from its formation.

H. Bottomley.

Under some conditions there is probably none, as where the water is drawn from a swift current or from a reservoir where the surface is much disturbed by wind. However, in some instances it is quite probable that conditions may be changed and the trouble overcome to some extent. We are led to think that a reservoir in close proximity to the power-house is an advantage, also a shelter from the wind. The current in our race is not strong and we are bothered with anchor ice only in windy weather. As we are situated, and for those who are near a reservoir, it occurs to us it would be worth while to try this experiment: Draw across the current some wire netting three or four feet in width, stapled on one edge to a light wooden boom to make it float; in the case of a long race, in several places. If on the side of a reservoir one or two such booms will gather the floating anchor ice and leave a chance for the water to pass underneath. Geo. M. Pierce.

B 2. Is there a method of preventing slush ice from forming on water-wheels?

See answer to question B 1. Jas. B. Foote.

Turbine water-wheels should be well housed, to exclude winds and the circulation of outside air, and the flume should be protected as much as possible. The water will thus be kept at a temperature that will in a great degree prevent the formation of ice upon the wheel. W. W. Titzell.

Keep the wheels in motion. E. T. Copeland.

With a 220-foot head, we have never been troubled with slush in our wheels. W. E. Moore.

See answer to question B 1. Harry D. Pope.

B 3. I have a 75-foot head of water and want to develop a maximum of 150 horse-power, but will use from 40 to 75 horse-power most of the time. What would be the best sizes of water-wheels?

Two water-wheels, turbine, of 75 horse-power each.
W. W. TITZELL.

Under 75 feet net effective head a pair of horizontal turbines, about 15 inches in diameter, delivering or discharging 1400 cubic feet of water per minute, and running 775 r.p.m., will develop 150 horse-power. For alternate use, or fractional use, they may be equipped with gate-operating mechanism, which will make practicable any desired subdivision. They must also be equipped with water cushion in order to be just right.
E. T. COPELAND.

We would suggest two 75-hp wheels. With this outfit one wheel can be run to its full capacity most of the time with highest efficiency. UNITED ELEC. LT. CO.

Two 75-hp wheels in separate pits.
AUGUSTA RY. AND ELEC. CO.

B 4. What is the general efficiency of a water-power plant at low heads?

The efficiency of a water-power plant would imply deduction of all losses from theoretical value of water—between heat and work. If efficiency of turbine under low head is meant, any vertical-shaft turbine, worthy of consideration, should show 80 per cent efficiency under any head not less than four feet.
E. T. COPELAND.

With good makes of wheels, from 75 to 80 per cent.
UNITED ELEC. LT. CO.

It depends on many conditions. Probably 50 to 60 per cent.
AUGUSTA RY. AND ELEC. CO.

B 5. What heads are most suitable (a) for turbines? (b) for impulse wheels?

Eighteen to 20-foot heads have been found best for the average types of cast-iron turbine wheels. W. W. Titzell.

Turbines are competent to do business without limit as to head, provided they are equipped with frictionless water cushion, which is an automatic hydraulic substitute for metallic or wooden steps and thrust bearings. Impulse wheels are competent under all heads, but especially under heads above 200 feet.

E. T. Copeland.

B 6. What instruments and what method are best for recording the head of water where instrument for recording height above the dam must be located a considerable distance from power station, and where head is often cut down by backwater in tail race?

Have a gauge consisting of a wooden rod attached to float in canal extending into wheel-room, with a pointer sliding over gauge board, the board being graduated in feet and inches from lowest to highest head, the height of rise and fall of tail water being handled in the same way. A. E. Walden.

Use a recording instrument made by the Lombard Governor Company; one to measure the head and the other the height of water in tail race. United Elec. Lt. Co.

See page 384, volume 45, *Electrical World and Engineer.*

J. F. Dostal.

There are electrical curve-drawing instruments for such work; one placed on the dam and another on the tail-water should show at all times the difference in head.

H. Bottomley.

A good method would be to have float operate rheostat or operate piston, transmitting motion by hydraulic pressure.

Augusta Ry. and Elec. Co.

B 7. What per cent variation of speed can be reasonably expected in practice on water-wheels driving a railway load, the wheels being equipped with Lombard governors?

With Lombard governor in good condition, and pressure on piston high enough to handle gates, three per cent should be the limit of variation in speed. CHARLES N. SHAW.

About two to three per cent, unless back-water conditions are bad. This is also governed to a certain extent by the momentum of the moving parts and the relation of horse-power of generator to horse-power of wheels. A. E. WALDEN.

The question of perfection of water-wheel governing on low heads largely depends on the type of wheel-gate selected and the construction of the penstocks, also the facility with which the water can rapidly get to the wheels. With water-wheel gates that move easily and are nearly balanced, and with large open penstocks where the water reaches the wheels at a very low velocity and without eddies, a speed variation of two and a half to three per cent is easily obtained with Lombard governors, under 50 per cent changes of load, such as occur in railroad work. JAS. B. FOOTE.

From five to six per cent. UNITED ELEC. LT. CO.

We get within two per cent. P. H. KORST.

Two per cent. AUGUSTA RY. AND ELEC. CO.

B 8. How close can a water-wheel governor be made to regulate under low heads (from 7 to 30 feet) operating on wheel having balanced register gates and a momentary load change of 50 per cent of the wheel capacity?

If balance wheels are properly placed to suit the conditions, the speed should not vary more than six per cent.

(UNSIGNED.)

See answer to question B 7. JAS. B. FOOTE.

Two per cent. AUGUSTA RY. AND ELEC. CO.

B 9. (a) Why is wood used as a bearing in water-wheels? (b) What is the best lubricant for such bearings?

(b) Graphite plugs. A. E. WALDEN.

Wooden steps are used because no metal would run any length of time without cutting all to pieces for lack of lubrication. Hard wood soaked in oil has been very much used. We have known a hemlock knot to be used for a step, and it lasted several years. Ofttimes the step of turbine water-wheels is above the tail water where it only gets the water that comes from the spray. No metal would stand under such circumstances. Some boil the wood for steps in beef tallow, so that the pores of the wood are filled with it. Graphite mixed with this tallow also helps greatly as a lubricant. W. W. TITZELL.

As I understand it, wood is used where bearing is submerged in water and exposed to the water, so that no lubricant can be applied. Two metal surfaces together will not run satisfactorily under such circumstances; the water would cool such a bearing but would not prevent rapid wear if the bearing were of metal. If proper wood is used and the bearing is always under water, it should run for years with very little wear. What wear there is should be taken up from time to time to keep the bearing in proper alignment. GEO. B. LAUDER.

Wood is used because friction is much less than with metal bearings and is also cheaper and more durable. Water is the best lubricant. J. D. SAUNDERS.

Lignum-vitae contains enough oil to lubricate itself, and any other lubricant or grooves for same would permit grit to get into gearing. AUGUSTA RY. AND ELEC. CO.

B 10. Has any practical method been in use to take the place of bevel gears on water-wheel transmission on wheels of 100 horse-power and larger?

This refers apparently to vertical wheels. There are a number of vertical wheels now designed to receive a generator on the top of the shaft, doing away with any gearing or belting. There are limitations to this type, depending upon head, power developed, *et cætera*. GEO. B. LAUDER.

Rope drive under proper conditions.
AUGUSTA RY. AND ELEC. CO.

Rope drive. E. W. FURBUSH.

For transmitting small amounts of power a twisted belt is sometimes used. For larger installations the only practical alternative would appear to be the use of a horizontal generator similar to those in the Niagara Falls installation.
H. T. HARTMAN.

B 11. What percentage of the power is lost in a bevel mortise wheel set on a vertical water-wheel?

It is generally considered that 8 to 12 per cent will represent the loss in large bevel-gear wheels and pinions used in connection with vertical waterwheels when the gears are well made and the shafts are well mounted. The chances are that the loss becomes materially larger with use, especially if the collars on the horizontal shaft become worn so that the wheels do not mesh in the best circles. DUGALD C. JACKSON.

B 12. How many months can a water-power plant afford to use a steam auxiliary?

It depends on size of installation and amount of saving to be obtained during hours of light load. A. E. WALDEN.

The time that a steam auxiliary would be economical depends upon cost of current and average receipts for the same, as well as on character of steam plant and cost of operation.
AUGUSTA RY. AND ELEC. CO.

This is a question depending so much on load conditions that it is difficult to offer an intelligent answer. No electric lighting plant can afford to shut down, and so there can hardly be a question of whether it can "afford to use a steam auxiliary" if there are times when the water-power is insufficient to supply the demand. If it is a question whether to increase the present capacity beyond the minimum capacity of the water-power plant, it resolves itself down to this: Will the additional business obtained pay for the interest and depreciation on the cost of the steam auxiliary, plus the cost of fuel, extra labor and supplies required during the period when the steam plant must be operated? If the additional receipts per kilowatt of demand load obtained exceed this figure it would pay to install the steam auxiliary. H. T. HARTMAN.

A question like this can not be given a general answer, because no two situations are alike, but there is a general feeling among people who have had experience with water-driven stations that there must be at least eight months of water to make the hydraulic development pay.

DUGALD C. JACKSON.

B 13. In a projected water-power development using a dam and head 20 feet high, what objections would there be to making the power-house a part of the dam when the natural conditions are favorable?

None; especially when concrete-steel construction can be used. A. E. WALDEN.

There is no objection to using the power-house as part of the dam. In fact, this is very good construction for heads under 40 or 50 feet. We have three power-houses now in operation that are so constructed, and the operation is perfectly satisfactory. JAS. B. FOOTE.

None whatever; but rather an advantage, for the reasons given in answer to question B 2. It also saves expenses of long flumes and penstocks, *et cætera*. Get close to the source of power.

W. W. TITZELL.

We think it would be desirable to have power-house part of the dam when the natural conditions are favorable.

P. H. KORST.

There are none. By so doing you take advantage of the depth of the river for a tail-race and very little excavating is necessary for a wheel-pit. A. R. MACKINNON.

We can not see that there would be any objection to making the power-house part of the dam in the water-power development such as you mention, if there would still be plenty of room for the flood water to pass. We should build the power-house high enough to be above any possible flood, and mount the generators directly on the horizontal shafting.

F. L. WILLIAMSON & CO.

There is a possibility of the breast wall leaking, also where the tail-water may rise very high there is possibility of the water getting into the wheels; nor does this method permit of readily cutting off the water from the power-house, in case of repairs, without a coffer dam. AUGUSTA RY. AND ELEC. CO.

B 14. What percentage of friction is there in a rope drive from vertical water-wheel to horizontal shaft?

B 15. In a water-power plant where there is a large amount of floor space, is it profitable to belt or gear the generator to the water-wheel on a 200-kilowatt generator? Give reasons.

Should prefer rope drive, as it is likely to be more reliable than belt, and certainly less noisy and more economical in operation than gearing. RALPH R. LAXTON.

Belting would be better in many cases.

AUGUSTA RY. AND ELEC. CO.

This is largely a matter of opinion. Personally, I should prefer to belt the generator rather than gear it to a water-wheel, for the reason that gears are very noisy, the efficiency is lower than that of a belt, and the repairs are comparatively high.

H. T. HARTMAN.

This question is one that should be settled to a great extent by the financial condition of the company. It will generally be found cheaper to belt a unit as small as 200-kw, as the stock sizes of these machines generally have a speed of from 600 to 1000 r.p.m. and the water-wheels are generally much slower than this. If the entire plant were being built, it might be found cheaper to direct-connect the generator to water-wheel shaft rather than to enlarge the power-house for belt drive and thus increase the first outlay. A. BALSLEY.

The connection with belt is to be preferred as a matter of original and maintenance cost, steadiness of drive, and quietness.
DUGALD C. JACKSON.

B 16. Is it good engineering to erect four or more water-wheels on one horizontal shaft in order to get speed under low heads for direct connection to generator?

Under some conditions it is the best way out of the difficulty. See Bell, *Electric Transmission of Power,* pages 342 to 345, third edition. RALPH R. LAXTON.

We have two generators, each direct-connected to three pairs of wheels in tandem, and consider it good practice.
A. R. MACKINNON.

If it is possible to govern them, and the head is sufficient to cover the wheels without loss of head, this plan should be satisfactory. AUGUSTA RY. AND ELEC. CO.

B 17. What is the safest means of preventing bursting of penstock when water-wheel gates are suddenly closed?

Open vertical standpipe connected to penstock and located close to wheel. If head is so high as to render this impracticable, the advisability of using Pelton wheels governing by deflecting nozzles instead of closing gates, might be considered.
RALPH R. LAXTON.

On moderate heads where it is practicable, I think a standpipe near the wheels will obviate this difficulty.
H. J. GILLE.

By employing suitable relief valves or air chambers. Many turbine water-wheels are equipped with air chambers and valves for this purpose. L. O. Veser.

Connect standpipe to penstock. Fred B. Sharpe.

A manhole cover held in place by bent lever and weight makes a good relief valve for this purpose.
Augusta Ry. and Elec. Co.

If the head on the wheels is low (not over 50 feet for instance), the cheapest and most effective way is to place a standpipe in the penstock near the power-house. This standpipe should have approximately the same diameter as the penstock, and should be ten or fifteen feet higher than the static head on the wheels.

For larger heads, an automatic balanced relief valve should be placed in the penstock, and the wheel gates should be arranged so that sudden closing is impossible.

With impulse wheels and a high head, the governing should be done by deflecting the nozzles and the valves should be slow closing. A. Balsley.

C

FEED WATER, HEATERS AND PUMPS

C 1. Please give a formula for boiler compound for water in which there is a heavy lime deposit.

We have never yet found an instance where lime was the principal substance that caused incrustation in steam boilers that washing soda (soda ash) used in conjunction with kerosene oil (refined petroleum) failed to remove it and prevent successfully the formation of more scale or incrustation. We have had under successful treatment scale composed of the following substances:

Analysis of Scale

	Per cent
Organic and volatile	7.3
Calcium carbonate	39.9
Lime	10.1
Calcium sulphate	5.3
Magnesia	18.1
Silica	10.9
Iron oxide and alumina	8.4

The process was simply to place within the boiler of 100 horse-power one bucketful of washing soda, put in two gallons of kerosene oil (after closing the blow-off cock), and fill the boiler with water. Feed in at least one quart of kerosene oil every day through a sight-feed oil cup attached to the feed pipe near the boiler—*i. e.,* between the heater and the boiler—so that the oil is not entrapped within the heater. If it is inconvenient to open the boiler, then dissolve the washing soda in hot water and feed it in with the pump or through a tallow cock (attached between the ejector and the valve in the suction pipe) when the ejector is working. W. W. TITZELL.

Forty pounds caustic soda, 40 pounds soda ash, 35 pounds liquid hemlock, 15 pounds gambier. Dissolve in hot water. This will make one barrel of good dissolvent. Where water contains much lime, add 20 pounds tri-soda and phosphate.

WM. WIATTE.

C 2. Which is preferable—to treat the water before it enters boilers or to use a high-fire kerosene and mechanical cleaner?

Treat water before feeding into boiler, foreign matter once eliminated can not cause any subsequent trouble. Kerosene in boilers is to be avoided because it does no good, causes joints in sectional boilers to leak, and is not a remedy for scale under any conditions. W. B. ROLAND.

Treat the water before it enters the boiler, either with a live steam feed-water purifier or with chemicals.

CHAS. N. SHAW.

If the plant is large enough to warrant the expense of a chemical purifier, this would be the proper course to pursue.

GEO. W. RICHARDSON.

We do not believe in mechanical tube-cleaners and have never had occasion to use one; they always injure the tubes. We do not believe that scale ought to be permitted to form within a steam boiler. It can in almost all cases be prevented.

W. W. TITZELL.

It is better to purify all water before it enters the boilers.
C. W. Koiner.

If the water is extremely bad it is much better to treat the water before it enters boilers if possible, as it is always desirable to keep the accumulation of scale-forming material out of the boiler. The Edison Elec. Ill'g Co. of West Chester, Pa.

Treat water before it enters boiler.
G. Wilbur Hubley.

Before entering boilers; through a compound feeder, connected to the feeder pipe and through the lower end of the compound feeder from pump. This will also prevent feed pipe from coating up. Wm. Wiatte.

Treat the water before it enters the boilers. You thereby do away with the greater part of your boiler-cleaning, and as your boilers are not as dirty you also maintain them at their highest efficiency. G. H. Cushman.

Treat it before entering boilers. G. F. Willard.

Before. The Edison Elec. Ill'g Co. of Brockton.

Treat water before it enters boilers. H. C. Hall.

Treat the water before it enters the boilers.
W. P. Hancock.

C 3. Does not kerosene oil, being itself a condensation from a still, vaporize before any benefit is derived when fed into working boilers to prevent scale?

Yes. A better method is to put about one gallon in boiler while empty, then as the boiler is filled the oil remains on top of water and adheres to shell and tubes as it rises in height.
Geo. W. Richardson.

No; it circulates with the water and does not remain on top of the water after ebullition begins. This we have demonstrated within glass models of boilers of various types and have attached stop-cocks to different parts of 100-hp boilers and when it was working have drawn from these cocks water that was strongly saturated or impregnated with kerosene oil.

W. W. TITZELL.

With our water at Colorado Springs we can find no benefit in the use of kerosene oil, but have found it a detriment for the following reasons: It will cause the steam-pipe system to leak at threads, and if gum packing is used to any extent, will cause it to be short-lived. THE COLORADO SPRINGS ELEC. CO.

Kerosene would vaporize at the temperature to which it is subjected in a boiler, if it were not under high pressure.

DAVID W. BEAMAN.

Judging from the benefits that have been obtained from its use, should say that it did not. H. BOTTOMLEY.

Kerosene is not very efficient in preventing boiler scale, and is not at all effective unless feeding takes place slowly.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Kerosene oil does not prevent scale, but is known to remove it to some extent when introduced with feed-water.

J. S. ROBINSON.

Not necessarily; we have used it several years with fair success until we found a better. W. P. HANCOCK.

C 4. Why do boiler-feed pipes coat on the inside with magnesia at the end inside the boiler more than they do anywhere in the run of the pipe?

Because the pipes get hotter at that point. C. E. BOWE.

Because the temperature is greater at inside end of the boiler-feed pipe and there the scale is deposited. The temperature outside is not sufficiently high to precipitate the scale-producing constituents. W. W. TITZELL.

Boiler-feed pipes coat with magnesia on the inside at each end of the boiler more readily than anywhere through the run of the pipe, on account of the water being hotter at that point.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

This is caused by higher temperature and possibly slower circulation at this portion of the feed-water pipes.
G. WILBUR HUBLEY.

I think the pipes get coated more on the inside of the boilers than on the outside because they are subjected to a much higher degree of temperature. O. H. YOUNG.

As a general rule boiler-feed pipes extend for quite a length into boiler shell. This being hotter than any other section of feed pipe causes a precipitation of the water and throwing down of any scale material. THE COLORADO SPRINGS ELEC. CO.

This is due to the fact that the temperature of the end immediately inside the boiler is high enough to precipitate the magnesia and other impurities. SAM'L KAHN.

Because it is at that point that the feed water first reaches a temperature high enough to throw down its solids, even though your heater is working at 210 degrees.
G. H. CUSHMAN.

The greater heat at this point produces greater precipitation
J. S. ROBINSON.

Chlorides of magnesium are precipitated at temperature of from 212 to 260 degrees Fahrenheit, so would be precipitated in the internal part of feed pipe where the temperature is higher than at any other part of feed system. W. P. HANCOCK.

C 5. How would you keep feed-water pipes clear of scale where the water is exceptionally full of magnesia carbonate?

Feed-water pipes can not be kept clean from scale, but have to be renewed from time to time. C. W. KOINER.

Treat the water before using. G. H. CUSHMAN.

Treat water before it enters feed-pipe or pump.
H. C. HALL.

C 6. Is it good engineering to place heater between engine and condenser?

Yes. The temperature of condensing water discharged from condenser is rarely above 90 to 100 degrees Fahrenheit and the use of a properly proportioned heater between engine and condenser will raise the temperature from 120 to 140 degrees and reduce the amount of injection water required eight to 10 per cent as well as the steam required to operate condenser.
A. E. WALDEN.

We have not found it good practice, because of the low temperature of steam under 26 to 27 inches of vacuum; the rise in temperature of the feed water being so slight that it was not a paying proposition. J. S. AVERY.

Yes. If you must have a heater it would be useless to place it anywhere else. GEO. W. RICHARDSON.

Yes, to get the benefit of the hot steam as it leaves the cylinder. W. W. TITZELL.

Yes, depending on conditions. G. WILBUR HUBLEY.

No, it is not; for the reason that the tubes in the heater will get to leaking and water will be liable to get into the cylinder of engine when condenser stops and engine is being shut down, and often, possibly, during operation.
WM. WIATTE.

It is surely much better to have a heater between the engines and the condenser, as it aids in heating the feed water as well as in condensing the exhaust steam. A second heater should be installed where steam-driven auxiliaries are used and thereby cover the energy otherwise wasted—the exhaust of the auxiliaries.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

With a heater between the engine and the condenser you take out some of the heat in the exhaust steam, and put it into the feed water, and at the same time reduce the work in the condenser, and thus increase its capacity.

G. B. LELAND.

I see no reason why a closed heater should not be placed between engine and condenser, provided a proper by-pass and relief are installed. THE COLORADO SPRINGS ELEC. CO.

Ordinarily, it is not good engineering to place a heater between the engine and condenser. The temperature of steam at two pounds absolute is 126.3 degrees Fahrenheit and that of the hot well is probably 120 degrees, so there is very little to be gained. The heater is an economy where there is an abundance of exhaust steam from the boiler-feed pumps and other auxiliaries, otherwise going to waste. SAM'L KAHN.

That depends on the cost of fuel, also upon how much you can heat your feed water from exhaust steam from auxiliary pumps. G. H. CUSHMAN.

Yes, if the quantity of steam from auxiliary apparatus is not enough to raise the feed water to a good temperature.

DAVID W. BEAMAN.

This depends on price of coal and amount of other exhaust for feed-water heating, and must be worked out for each plant.

W. P. HANCOCK.

A satisfactory increase in the economy of the station can be obtained by installing a feed-water heater between the engine and condenser. Care should be taken to have ample area through the steam space of the heater. I. E. MOULTROP.

No; the vacuum produced by the condenser has a cooling effect on the heater. It would be better to let the exhaust steam from the condenser and pumps exhaust into the heater at atmosphere pressure. F. W. BULLOCK.

This is a question on which "the doctors diagree" and it seems as if each particular case should be settled on its conditions. H. BOTTOMLEY.

It is not usual nowadays to place a heater between engine and condenser, as the gain is very slight and the maximum temperature can usually be obtained in a secondary heater.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

It depends upon whether or not the plant is to be equipped with an economizer; if so the gain in heat from heater placed between engine and condenser would not be sufficient to justify the cost. If not thus equipped there would be sufficient gain to make it good engineering practice to place a heater between engine and condenser. W. H. MILLS.

C 7. Is it good practice to turn exhaust from station auxiliaries into an open-type feed-water heater?

A closed heater of the even-flow type used with the same type of heater handling the exhaust from the auxiliaries will raise the feed temperature to 185 to 208 degrees Fahrenheit in a properly proportioned condensing plant. Where water conditions are exceptionally bad an open heater with provision for cleaning should be used. A. E. WALDEN.

Yes, if it does not affect the good working of the auxiliaries. In marine practice it is customary to turn the auxiliaries into the low-pressure receiver. GEO. W. RICHARDSON.

The exhaust steam from station auxiliaries is seldom sufficient to heat the feed water to 212 degrees and it matters little whether the heater is open or enclosed type.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Yes, up to the point of providing necessary amount of exhaust steam for increasing temperature of feed water.
G. WILBUR HUBLEY.

Yes. WM. WIATTE.

Yes; if you can raise the temperature from 126 to 210, you will decrease your fuel account about eight per cent.
G. H. CUSHMAN.

No. An open-type heater accumulates the oil, thus making poor water to feed the boilers. DAVID W. BEAMAN.

No; there is too much cylinder oil in the exhaust.
G. F. WILLARD.

There is no objection to the open-type feed-water heater operating on the exhaust of station auxiliaries, provided the installation is such that it is not necessary to keep the air out of the water. I. E. MOULTROP.

Not unless an oil separator is used.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

No. W. H. MILLS.

Yes, provided feed pump is below heater and in good condition. H. C. HALL.

C 8. Which is the more desirable type of feed-water heater for large plants, open or closed? Why?

It depends on the quality of feed water, but in any case should be operated with an outside packed plunger pump.
A. E. WALDEN.

Open-type feed-water heater is more desirable in large plants, for the following reasons:

First—Safety—operated under atmospheric pressure.

Second—Higher temperature of feed water when exhaust steam is used.

Third—Reliability and uniformity of operation.

Fourth—Less care and consequently less cost of maintenance. G. WILBUR HUBLEY.

Open heater will develope benefit of condensed steam.

WM. WIATTE.

Both types of feed-water heaters are good, and the selection of the type should be made in view of the requirements of the station in question. In a turbine installation where the condensing plant makes use of a dry-vacuum pump, there seems to be some advantage in the closed system, which keeps the water free from air after having passed once through the condenser. This installation would call for the use of a closed heater.

I. E. MOULTROP.

Open. It returns condensation to boiler, thus saving water and lessening scale deposit. It is easier kept clean, thus insuring better efficiency. J. T. COWLING.

Closed, if water is cheap, to avoid the possibility of oil being carried into the boilers.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Closed, all things considered. The advantages of a closed heater are: First, where city water is used, we get the benefit of its pressure, giving the pump less pressure to pump against; second, we get no effect of cylinder oil that the exhaust steam contains; third, the pump will have to handle cool water only, therefore will be more easily cared for. An open heater has the advantage of being more easily cleaned; also of giving hotter water, because the water mixes with the exhaust steam; but to offset this the pump will need more attention; also, oil is liable to get into the boilers, and last, the pump must be flooded.

H. C. HALL.

C 9. In a water heater should the steam first meet cold water? Give reasons.

The greater the difference of temperature, the more rapidly the heat will be transferred to feed water, and the rapidity will increase with the volume of the feed water.

A. E. WALDEN.

In an open water heater the steam should first meet cold water, so as to increase the economy of the auxiliary steam apparatus. E. E. LEE.

No; the feed water should leave the heater at the point where the exhaust steam enters, in order that the temperature may be raised to the highest degree before leaving the heater. Refer to Lowe heater where the pipe enters the top of heater and exhausts at the bottom. In this case the temperatures pass one another and the heater is packed full of exhaust steam, thus attaining as high as 216 degrees Fahrenheit in the feed water that leaves the heater at the top. W. W. TITZELL.

Could never see whether the steam or water should flow in opposite directions through the heater.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

If the steam first meets cold water there is simply that much more difference in temperature and possibility of expansion and contraction. AUGUSTA RY. AND ELEC. CO.

The flow of steam should meet the flow of water, the hottest steam meeting the hottest water and the coldest steam the coldest water. This gives a better transfer of heat than when arranged so that coldest steam meets hottest water.
J. S. ROBINSON.

C 10. What is the life of a hot-water meter when run continuously at full capacity?

The life of the hot-water meter we used continuously at full capacity was but eight months. O. H. YOUNG.

A hot-water meter run continuously at full capacity will, by reason of wear, have an error of about five per cent within ten days. THE EDISON ILL'G CO. OF DETROIT.

C 11. What is the benefit of an air chamber on a boiler-feed pump?

None; although it is advisable to have same on pump (except a duplex), in case it has to be used for other duty.

GEO. W. RICHARDSON.

To introduce an elastic medium into the water and prevent water-hammer and the valves from slamming. Air chambers also prevent shocks on the pumps and pipes. Where the lift is, say, 15 to 18 feet there should be an air chamber on the suction pipe. W. W. TITZELL.

The air chamber of boiler-feed pump relieves the feed lines to a certain extent of water-hammer due to the sudden changes in flow of water in the pipes. In duplex double-acting pump working at slow speed it is of no practical use.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

An air chamber on boiler-feed pump serves the purpose of giving a steady flow of water by the air in the top of said chamber serving as a cushion. C. W. KOINER.

Air chamber on boiler-feed pump prevents sudden pulsations and consequent water-hammer in piping system and also governs the uniformity of flow of water from pump.

G. WILBUR HUBLEY.

I don't think an air chamber on a boiler-feed pump is of any benefit whatever. O. H. YOUNG.

The air acts as a cushion for the surging water due to the action of the pump, and prevents water-hammer in the feed pipes.

G. H. CUSHMAN.

To cushion the irregular pressure and keep the flow of water constant. J. D. SAUNDERS.

By using an air chamber the steam can be used expansively, and if the outlet pipe be suddenly closed the air allows of compression, which takes away any jar on the pump that would otherwise take place. G. F. WILLARD.

It saves shocks to the feed piping when pump reverses.
W. P. HANCOCK.

The air chamber on a boiler-feed pump is useful to straighten out the pulsations in the feed line due to the piston of the pump reversing its direction quickly. It maintains a fairly even pressure in the piping, saving the piping from rather severe strains which it would receive if the pump were allowed to get out of good operating condition.
I. E. MOULTROP.

An air chamber on a boiler-feed pump is necessary as a cushion for the piping and boiler shell.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

An air chamber would relieve the pump and valves when check-valve leaks. AUGUSTA RY. AND ELEC. CO.

It stops the pounding of the check valves and makes the flow of feed water more continuous. W. H. MILLS.

The cushioning of the air in the top of the air chamber deadens the shock at each end of the stroke. Also causes pump to give a continuous discharge. H. C. HALL.

C 12. What has been the experience with rubber valve seats in marine-type boiler-feed pumps as to reliability and average life, and under what conditions?

Life is shorter, but not so reliable when using hot water.
GEO. W. RICHARDSON.

C 13. (a) What advantage has accrued from using metallic packing on the plungers of duplex outside-packed plunger feed pumps of Worthington type operated against 180 pounds pressure? (b) What guarantee has been obtained from makers of this type of packing on service as outlined above?

No metallic packing that we are aware of has been used satisfactorily upon plungers or water pistons, and we know no one who will reliably guarantee satisfactory results at present for this service. W. W. TITZELL.

Metallic packing on plungers of outside-packing plunger feed pumps has the advantage of keeping reasonably tight without causing undue wear, scoring, *et cætera,* on the pump plungers. It saves a lot of expense that is incurred by having to renew soft packing frequently, and in case of horizontal plungers it maintains the plunger in proper alignment; whereas with the soft packing the weight of the plunger causes it to wear away the soft packing on the underside and drop toward the bottom of the pump. The makers of metallic packing should guarantee the repairs on their packing for several years.

I. E. MOULTROP.

C 14. (a) What has been the experience in pumping water with compressed air? (b) What horse-power would be required to force water with compressed air a distance of 400 feet, the height from water level to top of tank being 100 feet; amount of water required would be 30,000 gallons in 24 hours?

This requires about 500 hp-hours for each 375,000 gallons raised 200 feet by the air lift and varies with the condition of pipes in the wells. A. E. WALDEN.

It is being successfully done in many places in this city. Horse-power required is figured as follows: Amount of water delivered per minute is approximately 20 gallons. Weight of this water is about 175 pounds. Calling the total lift 500 feet, we have 500 x 175 = 87,500 foot-pounds of work done per minute.

$$\frac{87{,}500}{33{,}000} = 2.65 \text{ horse-power actually required.}$$

Assuming an efficiency of 50 per cent (which is an average one) makes about 6-hp unit needed to do the work.

C. F. HAYWOOD.

C 15. (a) Is any scheme more economical in a non-condensing plant than motor-driven centrifugal pumps for boiler feed? (b) With a steam pump for starting reserve, is any more reliability warranted?

A power-plunger pump, belt-driven, feeding through a heater, is the most economical way to feed steam boilers. If shafting is used in the power-house, belt from it; if not, attach an electric motor. Such combinations are furnished by all the principal pump builders. W. W. Titzell.

Better economy and reliability in service is obtained by using steam-driven auxiliaries and you have the benefit of exhaust steam for increasing temperature of feed water.

G. Wilbur Hubley.

In a non-condensing plant the motor-driven boiler-feed pump is doubtless the most economical form that can be employed. Centrifugal feed pumps have hardly had sufficient use to demonstrate their reliability. If motor-driven pumps are used, one steam-driven pump or injectors should be installed for use when the generators are all shut down.

I. E. Moultrop.

C 16. Which are preferable in connection with turbine plants, motor or steam-driven auxiliaries?

We propose to use motors in connection with circulating and air pump, the pump to return the water of condensation to boilers; steam pumps for the step-bearing. I think this question would, to some extent, be determined by the amount of exhaust steam available. W. P. Hazeltine.

Steam-driven, as the temperature is very low in condensers of the surface type under high vacuum. A. E. Walden.

Motor-driven auxiliaries in connection with steam-turbine plants are preferable, in view of the fact that they are more efficient. C. W. Koiner.

In a turbine plant enough of the auxiliaries should be run by steam so that the feed water can be brought to the proper temperature, and this will depend on whether or not you can use the waste heat from the boilers for the purpose. With an economizer fewer of the auxiliaries will need to be run by steam.

G. B. Leland.

In turbine plants, steam-driven auxiliaries will be the more economical up to the point when all the exhaust steam can be condensed in heating the feed water. Beyond that point motor-driven auxiliaries should be used. I. E. MOULTROP.

No fixed rule; depends on local conditions; amount of exhaust steam needed for heating feed water, space available, etc. If steam and motor-driven exciters are used they could be run alternately, depending upon the amount of exhaust needed for heating feed-water, and under such conditions a combination of both motor and engine drive for condenser auxiliaries would be desirable.

Motor drive for air pump where power needed is constant, and engine drive for circulating pump where power needed varies with the temperature of condensing water.

J. T. COWLING.

C 17. What is the efficiency of a feed-water injector in the ratio of work done and heat returned to boiler to heat taken from boiler?

This matter is worked out in Peabody's *Thermo-Dynamics of Steam and Other Heating Engines*, published by John Wiley and Sons. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Some makers claim as high as 98 to 99 per cent; it should not be inferred from this that the injector is an economical machine for boiler-feed purposes as when used as a boiler-feed its efficiency is but about 1.5 per cent better than a steam pump feeding cold water to the boiler, and not that when the exhaust from the pump is turned into the suction and utilized to heat the feed water. It is very often claimed that as the injector puts water into the boiler at 150 to 200 degrees Fahrenheit it is a very economical boiler feeder, but it should be remembered that all the heat imparted to the water is taken from the boiler itself. E. W. FURBUSH.

The Babcock and Wilcox Company in its book entitled, *Steam* publishes a table that shows that without the heater the direct-acting feed pump and the injector have about the same relative economy. Feeding through a feed-water heater and direct-acting feed pump is about six per cent more economical than the injector. I. E. MOULTROP.

C 18. How can the water in a Cochrane water-heater and purifier, properly connected up (in accordance with manufacturer's directions), be increased to a greater efficiency than 190 degrees?

By increasing the back pressure to four or five pounds.
W. B. ROLAND.

We find no difficulty in heating water to 208 degrees Fahrenheit in a Cochrane heater. Probably air-pipe is not sufficiently large to prevent binding. A. PETERS.

C 19. We have heater, purifier and feed pump which delivers the water to the boilers at 206 degrees Fahrenheit. Is this fairly economical?

Yes; very good. G. WILBUR HUBLEY.

Consider 206 degrees Fahrenheit good practice; have seen 210 degrees Fahrenheit with the Cochrane system.
W. B. ROLAND.

Yes; but you do not state your altitude.
GEO. W. RICHARDSON.

Yes; but it could probably be improved if the details of heater arrangements were given. W. W. TITZELL.

Yes, as no economizers are in use.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

You could not expect any better results from the heater than you are getting—206 degrees Fahrenheit.
C. W. KOINER.

Yes. WM. WIATTE.

Feed water to boilers at 206 degrees Fahrenheit should be fairly economical, but think the cost of the heater, purifier and feed pump would need to be considered. O. H. YOUNG.

Yes. G. H. CUSHMAN.

Yes. C. F. HAYWOOD.

This performance is fairly good, but 210 degrees can be obtained. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

C 20. Is there a hot-water meter made, accurate enough to be used on boiler feed, to calculate the efficiency of the boiler and plant?

There is a reliable hot-water meter made by the Worthington works. It, however, is made to order only, as I understand it, and is not put on the market in any quantity.
WALTER FLINT.

Hot-water meters are not ideal instruments. They can be used on a boiler test with very good satisfaction by taking care to carefully calibrate the meter in position on the boiler immediately before and after the boiler test.
I. E. MOULTROP.

The Worthington hot-water meter is sufficiently accurate on 24-hour run to be used as a test meter in a calculation of boiler efficiency. It should, of course, be checked before and after using. The error ought to be within one-half of one per cent if the meter is in good order to begin with.
THE EDISON ILL'G CO. OF DETROIT.

The Worthington piston type or Venturi water meter.
AUGUSTA RY. AND ELEC. CO.

Yes; the Worthington hot-water meter.
W. H. MILLS.

We are using three four-inch hot-water meters at our Fisk street station. The water that they measure has an average temperature of 150 degrees Fahrenheit, and is delivered to the boiler through the meters under a pressure of 190 pounds per square inch. The meters have been calibrated at various times, but the greatest error found was three per cent, and the average error slightly less than one per cent, which we consider accurate enough to use in connection with boiler and steam-plant efficiency. A. A. FAILMETZGER.

We have never found a water meter that was accurate over a wide range of capacity and pressure. With individual meters for each boiler reasonably close results will be obtained. Even if they are not absolutely accurate (and they are not likely to be), the relative indications will be fairly reliable, and this is the important point, after all, as it shows any variations due to changes in the quality of coal or method of operation of the plant. H. T. HARTMAN.

While meters carrying water at a high temperature and pressure can hardly be termed accurate or reliable, they afford a valuable check upon the conduct of the plant. For test purposes the meters should be checked or measurements made by weighing tanks. A. S. KIBBE.

From the results of several tests of boiler efficiency made in cases where the water was weighed and checked against hot-water-meter readings, it is doubtful if sufficiently accurate results could be obtained for thorough efficiency tests. For daily records or as a check upon the running evaporative results in a plant, the hot-water meters will probably introduce no greater errors than any other recording steam or electrical instruments used in maintaining such daily records.

THE PHILADELPHIA ELEC. CO.

Yes; the Worthington duplex double-acting piston pattern meter, fitted with adjustable tappets in the heads. This is the only adjustable meter made, and, consequently, is the only type of measuring machine suited for such a service as measuring hot feed water under pressure where continued accuracy is essential. Of course any machine of any character having metal bearing surfaces will wear sooner or later, and such wear will result in inaccuracy, but if means are provided to compensate for the wear the problem is solved. This is what is accomplished in the Worthington hot-water meter, as the measurement is accomplished by the alternate filling and emptying of cylinders in which plungers move back and forth, and, therefore, by the lengthening or shortening of the plunger stroke (as may be necessary) by means of the adjustable tappets in the ends of the cylinders, the plunger displacement may be brought into exact balance with the counter reading. By having the meter properly piped on by a by-pass, it may be calibrated in a few minutes and as frequently as desired, under the actual working conditions, without breaking the piping or opening the meter.

GEO. H. GIBSON.

The Henry R. Worthington hot-water meter will give good results when new. The meters used for efficiency tests should not be used for any other service, as they are subject to considerable wear which affects the accuracy of meter. In any case, they should be checked before making any test of importance by weighing, say, fifty cubic feet of water, previously measured by meter under as nearly as possible the same conditions as to temperature of water and speed as meter will be subjected to during test.

J. A. MALONEY.

D

FUEL

D 1. Which would be the more economical for stoker use—washed screenings of low-grade coal or the slack from high-grade coal?

Slack from high-grade coal. These fine grades of coal should be well protected from the action of the elements, as they deteriorate very rapidly.

W. W. TITZELL.

The most economical coal to be used with a stoker depends largely on the heat units being obtained from the different grades of rice and slack. The best way to determine which coal is the most economical is to use a waste meter on the boiler-feed pipe and find how much water can be evaporated with one dollar's worth of coal.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

The most economical fuel to use is that which will evaporate the most water for $1.00. C. W. KOINER.

Slack from high-grade coal. G. WILBUR HUBLEY.

D 2. What kind of coal is the better to use, from an economical standpoint, rice or buckwheat, when the difference in price is $1.50 to $2.00 per ton?

I conducted a test with 100 tons each, rice, buckwheat, pea, chestnut, and bituminous coals. I found the cost of buckwheat per pound to be cheaper per pound of product than that of either of the other grades. W. B. ROLAND.

Usually buckwheat. W. W. TITZELL.

See answer to question D 1.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Rice coal on mechanical stokers. (UNSIGNED.)

D 3. In a hand-fired plant, with limited boiler capacity, which is considered the cheapest fuel, bituminous screenings, run of mine or lump?

Run of mine, with intelligent firing.

CHAS. N. SHAW.

Use the coal that will give the greatest number of watt-hours per pound of coal; usually lump coal.

A. E. WALDEN.

Screenings, when washed and at same price as mine run. With limited boiler capacity, screenings make by far the cheapest fuel. GEO. W. RICHARDSON.

A mixture of buckwheat and soft or semi-bituminous coal in a proportion of three to one or, if it will do, four to one.

W. W. TITZELL.

Boiler capacity will be very much increased by the use of lump coal. If draft is poor it will usually be found more economical should the coal all be a production of the same mine or be of equal heat units.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

After tests, we have found screenings—that is, nut and slack mixed—the cheapest fuel, lump (although not so much is used) being the most expensive. A. PETERS.

Run of mine. G. WILBUR HUBLEY.

If boiler capacity is limited to such an extent as to demand greatest capacity from the boilers, there is no choice but to use that coal which will produce it. If greatest capacity is not demanded, local conditions and the price of coal must be considered in determining the logical answer to the question.

E. J. BECHTEL.

It is more economical in the West to use bituminous screenings. J. D. SAUNDERS.

Run of mine. W. P. HANCOCK.

D 4. What experience have you had with use of slack coal in connection with automatic stokers, and what grade have you found most satisfactory, very fine slack, mixture of slack and pea, or slack, pea and nut, or only pea or nut sizes?

Nut and pea coal usually work best. A. E. WALDEN.

Have found slack and rice coals to be about as good as any other mixture.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Nut and slack. G. WILBUR HUBLEY.

We have two Heine boilers with Wilkinson automatic stokers and find that we can get as good results from rice coal as from buckwheat. We also find that by using either one separately we get better results than with a mixture of both. (UNSIGNED.)

We are obtaining satisfactory results from chain-grate stokers; burning pea and slack size of coal of the following average analysis:

Moisture	3.13 per cent
Volatile comb. matter	34.54 " "
Fixed carbon	52.92 " "
Ash	9.41 " "
Heat value	12,500 B. t. u.

E. J. BECHTEL.

D 5. With a smoke ordinance in force, and with fuel prices as follows—bituminous (run of mine), $2.95 per ton; anthracite, pea, $3.30 per ton; anthracite No. 1, buckwheat, $2.70 per ton; anthracite No. 2, buckwheat, $2.05 per ton; anthracite No. 3, buckwheat, $1.80 per ton—which would be the more economical fuel or mixture to use (a) with natural draft, (b) with forced draft?

(a) Number one buckwheat.
(b) Number three buckwheat.

CHARLES N. SHAW.

Twenty-five per cent slack soft, 25 per cent pea and 50 per cent of No. 1 or No. 2 buckwheat coal gives a cheap and satisfactory result. At the United States Cotton Company's mill at Central Falls, R. I., the fuel cost with this mixture is $5.95 per horse-power per year when used with forced draft, the fans being large enough to deliver a large quantity of air at a low velocity using the hot air from over the tops of the boilers. A. E. WALDEN.

We have found that where a smoke ordinance is enforced it is necessary to use George's Creek and New River coal, and we have adopted Murphy stokers. With this outfit, no smoke is observed coming from our stacks when we are running under full load. Without a reliable smoke-consuming device, we should think it would depend on who enforced a smoke ordinance as to what kind of fuel could be used.

UNITED ELEC. LT. CO.

(a) With natural draft, one-third bituminous, two-thirds No. 3 buckwheat.

(b) With forced draft, No. 3 buckwheat.

FRED B. SHARPE.

With natural draft, a mixture of 75 per cent No. 2 buckwheat and 25 per cent bituminous will make no smoke and will give practically the same results as bituminous coal, as to cost. Boiler capacity would be reduced slightly.

J. T. COWLING.

D 6. (a) Do you weigh your coal as it comes from barge or cars and check up bill of lading for weight? (b) What redress has been obtained in case of shortage?

We check weights of from 10 per cent to 20 per cent of the cars, and find railroad weights satisfactory.

E. J. BECHTEL.

(a) Coal is usually bought f. o. b. mines or docks at original shipping points.

(b) Technically, no redress is possible; practically, if continued shortage occurs, coal companies will stand it rather than lose a good consumer. R. N. KIMBALL.

We weigh coal by the barrow, as it is hauled from pile to the front of boiler, and never knew of any redress being obtained for shortage, even if car was checked by special request at point of receipt. AUGUSTA RY. AND ELEC. CO.

Coal should always be weighed to check bill of lading weight, as otherwise no reliable data can be obtained as to station economy. The shortage will probably be greatest in the winter months, and has averaged two per cent to three per cent in the writer's experience, being as high as 15 per cent in individual cases. Exposure of car to rain must be taken into consideration, as slack and run of mine, poor in lump, will absorb a very large percentage of moisture.

No redress against the railway companies has been found possible when shortage has occurred, except when a state has a Board of Corporation Commissioners, empowered to regulate abuses. M. CARRINGTON.

It is impossible to keep an accurate check on the shipping weight of coal unless the car is weighed upon arrival. If an attempt is made to check coal as it is burned by separating the various shipments as received, too long a time elapses before the results are available. Moreover, weighing a carload of coal one barrowful at a time is a very inaccurate method. Where it has been possible for us to weigh the cars as received, we have found it impossible to obtain any redress whatever in case of shortage. H. T. HARTMAN.

Coal is weighed at all of our plants as it comes from vessel or cars. Contracts in different localities differ, but we have always received reasonable treatment on the part of shippers where great shortage has been demonstrated and in some instances our own weights have governed. A. S. KIBBE.

D 7. (a) What success has been met with by companies who buy coal on the basis of the heat values contained therein, determined by calorimeter test and chemical analysis? (b) What is the standard specification for heat value and chemical analysis, and what penalty is imposed for non-fulfillment of contract made on above basis? (c) What is the method used for the sampling of the coal, and (d) what is the method of settling differences shown by analyses made by several chemists, which do not check with each other?

Without attempting to say anything about successful outcome of coal-testing methods, I wish to call attention to an opportunity for error, which may not only cause trouble but may throw discredit on testing methods. It is the determination of fixed carbon and volatile matter, or, in other words, the volatilization. It should occur in a non-oxidizing atmosphere if correct results are obtained. In this connection, those interested should read a paper by Mead and Attix, *Journal* of the American Chemical Society, volume 21, page 1137.

A. BEMENT.

Where considerable quantities of coal are to be purchased it is very desirable to specify the heat value of the coal and to make a calorimeter test of the coal delivered. The value of the coal when used under the boiler is not directly indicated by the result of the calorimeter test, but it is more nearly indicated by the calorimeter test than by ordinary chemical analysis. It is impossible to give any standard specification for the heat value of coal, because the different kinds of coal differ very much, and each purchaser should learn the best heat values that may be expected from the coals to be purchased in his region. Having done this, the purchaser's contract should require the coal to reach this figure. The contract may nominate that a failure to fulfil the specifications with respect to heat units shall afford the purchaser the privilege of refusing to accept and use the coal or the privilege of accepting the coal and paying a price reduced from the contract price in proportion to the deficit of heat units.

It is necessary to get an average sample from each shipment, and this can be done by taking average shovelfuls from numerous points in the pile or in a car-load, mixing them thoroughly, and saving several samples of not less than a pound each to be taken from different points in this pile. These samples should be then thoroughly mixed and pulverized. The test sample may be taken at random from this pulverized mass. If the sampling and testing have been carefully done, calorimeter tests made by different men of experience and skill ought not to differ much.

DUGALD C. JACKSON.

This company has been buying its coal for the past two years on the basis of heat contained therein, as per extract from the contract, which follows:

"It is mutually understood and agreed that all coal delivered under this contract is to be of the grade known as.................... , and is to come from the................district.. .. .. and that said coal is to be the same in quality and grade, in all respects, as the sample of coal upon which this contract is based, which was taken from the.................... building on the..........day of......... ....190.., and the chemical analysis of which sample is as follows:

British thermal units per
pound of dry coal ... .
Percentage of moisture ....
Percentage of ash, dry...........

and to this end it is mutually agreed that the consumer may cause to be analyzed, from time to time, samples of the coal delivered hereunder and at its option (1st) reject any or all coal not coming up to said sample in any or all respects, or (2d) accept any coal not coming up to said sample, in which event the consumer shall pay the company such a price for such inferior coal as shall make such inferior coal equal in value to the consumer to the coal contracted for hereunder, such reduced price to bear such a proportion to the contract price stipulated herein as the decreased value of said inferior coal bears to the value of said sample of coal as determined by the relative amounts of British thermal units contained in said coals."

Thus far we have experienced no difficulty in making settlement at the end of the year on the basis of our own analyses. There are two firms in Chicago who make a business of analyzing coal at regular intervals for just such purposes.

ILLINOIS MAINTENANCE CO.

The best method of determining the value of the coal is by carefully weighing the amount fired and recording the kilowatt-hour output of your plant during this test. The coal that gives the greatest efficiency is, of course, the best coal to buy, regardless of its theoretical heat value and chemical analysis.

E. F. McCABE.

D 8. What is the best method of firing coke? In a plant where both coke and soft coal must be used, should the two fuels be mixed or fired separately?

It is better to fire coke alone than to mix it with coal.

C. W. KOINER.

In using soft coal and coke we have found it best that they be mixed two parts coal and one part coke.

E. F. McCABE.

D 9. Is one and a half cords of pine wood excessive for a 7 hours' run with an average load of 26 amperes, 1100 volts?

No. GEO. W. RICHARDSON.

The kind of boiler and engine in use or temperature of feed water not being given, it is hard to say; but assuming that the engine is of a size suitable for the work, or about 50 i.h.p. nominal rating, to carry 26 amperes at 1100 volts requires 26 × 1100 = 28.6 kilowatts or 38.32 electrical horse-power. Assuming the efficiency of the engine and generator at 80 per cent, 48 i.h.p. would be required to do the work. Assuming the engine to be a good four-valve machine and the boiler to evaporate eight pounds water to the pound of coal, about three pounds of coal would be required per i.h.p. per hour, or about 1000 pounds of coal for the seven hours' run. Wood being taken at four-tenths the value of coal for the same weight, 1000 ÷ .4 = 2500 pounds of dry wood required to do the same work. Weight of white pine per cord is given as 1868 pounds, 1.5 cords equal 2802 pounds of wood used; this would be considered good work for an engine of this type.

E. W. FURBUSH.

One and one-half cords of pine wood would weigh about 1200 pounds, and as it will average about 9000 B. t. u. per pound, the amount of fuel used would be equivalent to about 1800 pounds of coal. The output mentioned would be 200.2 kilowatt-hours, indicating a fuel consumption equal to nine pounds of coal per kilowatt-hour, which is about what would be expected with a small, non-condensing, high-speed engine.

H. T. HARTMAN.

One and one-half cords of yellow pine = .36 tons of bituminous coal or 720 pounds; 26 amperes at 1100 volts single-phase and unity power factor = 28.6 kilowatts, and this for seven hours = 200.2 kilowatt-hours. Dividing the coal consumption by the kilowatt-hours gives practically 3.6 pounds coal per kilowatt-hour. In a plant delivering only 26 amperes at 1100 volts, this is a very good showing. W. R. COLLINS.

D 10. Is peat in practical use as power fuel in the United States?

No. Many experiments have been tried to utilize peat for fuel, but thus far the greatest difficulty has been in drying it economically so as to compete in price with coal.

W. W. TITZELL.

Numerous trials of peat as fuel have resulted in failure in the United States. I know of no case of successful use in large quantities. H. T. HARTMAN.

D 11. Have you had experience with oil as a fuel? If so, how has the cost compared with coal, taking into consideration all labor and handling factors? Have you had any trouble by reason of uncertain deliveries?

One pound of oil will evaporate 14 to 15 pounds of water, consuming seven to eight per cent of the steam generated to operate the burners. Using heated compressed air in place of steam increases the evaporation quite considerably. Burners giving these results can be obtained on the market.

A. E. WALDEN.

See *Power,* January issue, 1905. GEO. W. RICHARDSON.

With lignite coal at $1.91 per ton, oil will be the cheaper until the price per barrel passes $1.10—42 gallons per barrel.

G. H. CUSHMAN.

In 1892 there were reported to the Engineers' Club of Philadelphia, some comparative figures from tests undertaken to ascertain the relative values of coal and oil as fuel.

One pound anthracite coal evaporated from and at 212° F., 9.70 pounds water
One pound bituminous coal evaporated from and at 212° F., 10.14 pounds water
One pound oil evaporated from and at 212° F., 16.48 pounds water

Taking the efficiency of the bituminous coal as a basis, the calorific energy of petroleum is more than 60 per cent greater than that of coal; whereas, theoretically, petroleum exceeds coal only 45 per cent, the one containing 14,500 heat units and the other 21,000 heat units.

As a result of tests made in the northwest with ordinary Lima oil weighing 6.6 pounds per gallon, and costing 2.25 cents per gallon, and coal that gave an evaporation of 7.5 pounds of water per pound of coal, the two fuels were equally economical when the price of coal was $3.85 per ton of 2000 pounds. With the same coal at $2.00 per ton, the coal was 37 per cent more economical than the oil. With the coal at $4.85 per ton the coal was 20 per cent more expensive than the oil. These results include the difference in the cost of handling coal, ashes and oil.

C. C. GARTLAND.

D 12. Can bituminous coal be prevented from heating by inserting perforated pipes in the coal and forcing air through it at stated intervals, or by any method of ventilation?

Bituminous coal can be prevented from overheating and taking fire by inserting perforated pipes in the coal bin, also by ventilating shafts of brick, both horizontal and vertical. These will prove effective. The ventilation must be thorough.

C. W. KOINER.

As oxidation causes the heating of bituminous coal, it is questionable whether the heating would be lessened by supplying a greater quantity of oxygen. A more logical plan would be to smother the fire by entirely preventing additional oxygen from reaching it. The usual plan in case of spontaneous combustion in the coal pile is to spread all of the coal out as thinly as possible, so as to prevent the increase of heating that would result from the coal above acting as a non-conductor.

H. T. HARTMAN.

The supply of oxygen by ventilating systems would prove a source of danger in case of the starting of the coal to heat by chemical action. The rapid combustion of a mass of heated coal when uncovered to the air shows this. The best preventive known to the writer is to avoid depth in storing the coal, thus keeping down the pressure upon the lower mass. The coal should be kept in motion as much as possible if a known tendency to heat exists, by using from as great a surface area as practical, thus cooling by the fresh surfaces exposed. A practical way to do this, if cars or carts are used, is to cut alleys into the pile and use from all sides of the same instead of using from one side, as is often done.

THE PHILADELPHIA ELEC. CO.

D 13. Is it safe to store bituminous screenings within the boiler-room? If so, how much may safely be stored. and how long can it remain in storage?

Yes; provided it was not wet when stored, and is kept dry, it may be safely stored for any length of time.

GEO. W. RICHARDSON.

It will depend upon the bituminous coal. Have had it to take fire in ten days when stored in small quantities, nine feet in depth, and, again, where it was stored 15 feet deep there was no evidence of heating during a period of ten months.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Yes, if proper ventilation is provided. Advisable to completely rehandle stock supply about twice per year.

G. WILBUR HUBLEY.

D 14. Which of the following is the best standard by which to judge the value of coal: Percentage of ash, its size or heating power?

It would seem to me that the best standard by which to judge of the value of coal is the percentage of ash and waste that comes through the grate. We are at present using a brand of coal that chemically has eight per cent ash. The nearest we can possibly get in actual firing is 11 per cent, with an average of probably 12 or 13 per cent. This is due, not to the actual amount of ash in the coal, but to the amount of very fine coal that is bound to go through the grate unburned. It is quite possible that a mechanical method of firing would save a little more of this coal. Our method is entirely hand firing.

WALTER FLINT.

The comparative value of fuels depends upon so many features that are more or less complex that no single factor can be considered alone. Probably the number of heat units is the best indicator when taken singly, but fuels with equal calorific values, as shown by laboratory tests, may differ considerably in their values for boiler purposes. Of two otherwise equal fuels, the one with the smaller percentage of ash may ordinarily be considered the more economical. DUGALD C. JACKSON.

Heating power, or the amount of water evaporated per pound of coal; or, to make allowance for the difference of price in different kinds of coal, the amount of water evaporated per dollar. E. W. FURBUSH.

By the heat units gotten out of it for the least cost per unit.
E. A. BECHSTEIN.

Should judge the value of coal—first, by its heating value, as determined by an evaporation test made under same conditions as to furnace and type of boiler where it was to be used. Second, would consider the percentage of ash, which, if excessive, might reduce the value of coal, by increasing the cost of handling and maintenance of furnace; and third, should judge its value by its size; the very small sizes as a rule not being so efficient as the larger. J. A. MALONEY.

D 15. What is the cost of crushing and conveying coal per ton in stations where no hand shoveling is necessary?

In a station burning 350 tons per day, the cost per ton for conveying and crushing coal is as follows:

Conveyer labor and power	2.85 cents
Crusher labor and power	2.42 cents
Total	5.27 cents
Repairs on conveyer	.43 cent

Repairs on crusher were not obtainable.

S. B. CUSHING.

From three to seven cents per ton, depending on character of fuel, apparatus and general conditions.
H. T. HARTMAN.

Total lift, length of conveyer, and load factor, or amount of coal handled per day, are very important factors in the cost per ton. On account of the intermittent nature of our work, the fixed charges against the apparatus become quite an item in the total expense.

On a straight lift of fifty feet, coal dumped in crusher from hoppers of car, and horizontal conveyer of 100 feet to bunker, the total costs amount to 11 cents per ton, average amount handled 40 tons per day. Machinery all motor-driven and current estimated at cost.

On an inclined flight of 125 feet, and horizontal conveyer of 110 feet to bunker, coal hoisted from boat by steam and dumped into crusher which feeds to inclined flight, average amount handled 200 tons per day, total costs are six cents per ton. All machinery except hoisting from boat operated by electric motors.

On another straight lift from boat by motor hoist, dumping on belt conveyer which is about 200 feet long, incline to height of 50 feet dumping into bunker, average amount handled 300 tons per day, the costs are a trifle over 6 cents per ton.

THE PHILADELPHIA ELEC. CO.

One and a quarter kilowatt-hours per ton of coal with about 1400 feet of conveyer in operation with the crusher.

W. P. HANCOCK.

D 16. In a steam plant with 25 per cent load factor, non-condensing, 5 pounds back pressure, 160 pounds pressure, 200 degrees superheat, 2000-kilowatt capacity, engines 20 feet from boilers, chain-grate B. & W. stokers, what amount of run of mine coal per kilowatt-hour at station 'bus-bars? System direct-current, low-tension, 24 hours per day run.

Six pounds of coal per kilowatt-hour is average consumption.

H. J. MEYER.

Conditions mentioned are very bad, on account of the low load factor and high back pressure. I should judge that the amount of coal per kilowatt-hour would be at least eight pounds; probably higher.

H. T. HARTMAN.

Eight to ten pounds run-of-mine coal per kilowatt-hour is about as little as could be expected under the circumstances outlined. A. S. KIBBE.

If load factor given is derived from maximum capacity multiplied by 24 hours' run, should say that 5.2 would represent good work. If load factor is derived upon actual capacity and 24-hours run—in other words, six hours' use of the actual average boiler capacity on the line—the result might be slightly lower. THE PHILADELPHIA ELEC. CO.

Six pounds. FRED B. SHARPE.

D 17. What is the best method of firing the western lignite, that the combustion of the hydrocarbons may be complete?

Without having had the experience in firing western lignite, it would appear by analogy that the best method to insure the combustion of the hydrocarbons would be to employ some type of furnace that is most successful in burning long-flame bituminous coals without smoke; preferaby, a long brick arch or a tile roof over the furnace. (UNSIGNED.)

E

BOILERS AND MECHANICAL STOKERS

E 1. What is a good handy rule for determining horse-power of boilers?

Thirty pounds of water at 70 degrees Fahrenheit evaporated into steam at 212 degrees Fahrenheit per hour, or 34.5 pounds water at 212 degrees Fahrenheit evaporated into steam at 212 degrees Fahrenheit. W. B. ROLAND.

The rating of boilers is extremely indefinite. The ratio of heating surface to horse-power, when boiler is run under ordinary conditions, is as follows:

Water tube	10 to 12	sq. ft.	of heating	surface	per	horse-power
Fire tube	14 " 18	"	"	"	"	"
Flue	8 " 12	"	"	"	"	"
Plain cylindrical	6 " 10	"	"	"	"	"
Locomotive (stationary pract.)	12 " 16	"	"	"	"	"

But the accurate standard of a boiler horse-power is 34.5 pounds of water evaporated from a feed-water temperature of 212 degrees Fahrenheit into steam at the same temperature.

GEO. W. RICHARDSON.

A handy rule for determining the horse-power of boilers is to allow 10 feet of submerged heating surface per horse-power. Many manufacturers allow as low as seven feet per horse-power, but it requires a high flue temperature and lower economy to get the capacity on this basis.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Strictly speaking, there is no such thing as "horse-power" to a steam boiler; it is a measure applicable only to dynamic effect. But as boilers are necessary for driving steam engines, the same term applied to steam engines has come to be universally applied to boilers.

RULE: Divide the total water-heating surface in square feet by the number of square feet of heating area—as given in the table below—required to produce an evaporation equivalent to one horse-power in boilers of the given type.

TYPE OF BOILER	HEATING SURFACE FOR 1 HORSE-POWER SQUARE FEET
Water tube	10 to 12
Tubular	14 " 18
Flue	8 " 12
Plain cylinder	6 " 10
Locomotive	12 " 16
Vertical tubular	15 " 20

S. C. FOSTER.

Weigh the coal and weigh the water. Meters are not sufficiently reliable for accurate results. A tank may be graduated and tabulated so that scales may be dispensed with after weighing the first tank full. Allow 30 pounds to the horse-power per hour. W. W. TITZELL.

A common rule is to allow 15 to 18 square feet of heating surface per horse-power in return tubular boilers and 10 to 12 square feet for water tube. A. PETERS.

Divide number of pounds of water evaporated from and at 212 degrees Fahrenheit by 34.48. G. WILBUR HUBLEY.

This formula may be used for horizontal tubular boilers:

$$\frac{\text{Heating surface in square feet}}{11.5}$$

For heating surface, figure on area of inside of tubes, one-half shell, and one end. SAM'L KAHN.

The proper rule for determining the horse-power of a boiler is based on the capacity of the boiler for evaporating water. Approximately 10 square feet of heating surface that is in contact with water may be accepted as sufficient to supply the necessary evaporating area for one rated boiler-horse-power in most types of boilers. The horse-power of a boiler is therefore equal to the heating surface in contact with water, divided by 10. When using this rule, it must be remembered that a rated boiler-horse-power may afford each hour more or less steam than is consumed per indicated-horse-power by the engine to which the boilers supply steam. With a thoroughly efficient engine, each rated boiler-horse-power is more than sufficient to supply the steam consumed per each indicated-horse-power.
DUGALD C. JACKSON.

See page 679, Kent's *Mechanical Engineer's Pocket Book.*
G. H. CUSHMAN.

About 12 square feet of heating surface per horse-power.
AUGUSTA RY. AND ELEC. CO.

There is no good, handy rule for determining the horse-power of boilers; if there were, it would vary with each type and style of boiler. In return tubular boilers a heating surface of 12 to 13 square feet per horse-power is often used. The best method of determining the horse-power of a boiler is the evaporative test, using the American Society of Mechanical Engineers' standard, 30 pounds of water evaporated per horse-power-hour from and at 212 degrees Fahrenheit. E. F. MCCABE.

A committee of the American Society of Mechanical Engineers recommended 30 pounds of water as the unit of boiler power, and this is now generally accepted. It advises that the commercial rating be taken as an evaporation of 30 pounds of water per hour from a feed temperature of 100 degrees Fahrenheit into steam of 70 pounds gauge pressure, which may be considered to be equal to 34.5 units of evaporation; that is 34.5 pounds of water from a feed temperature of 212 degrees into steam at same temperature. This standard is equal to 33.305 B. t. u. per hour. C. C. GARTLAND.

E 2. Has the efficiency of boilers been increased in the past 25 years, and if not, why not?

The efficiency of boilers has not been increased much in the last twenty-five years. There has been some increase in the efficiency of boiler plants by the addition of economizing auxiliaries. The boiler itself is doing very little better now than a quarter century ago, if we consider the best types that were in use at that time.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Yes, approximately 50 per cent increase of efficiency.

G. WILBUR HUBLEY.

Because people have not studied and do not study such matters thoroughly. They fail to get to the bottom of the problem and consider it in its individual aspects. It is assumed, of course, that the inquirer in his use of the word "boiler" refers rather to the entire apparatus of which the boiler is only a portion. A. BEMENT.

The efficiency of boilers has certainly been increased since the Babcock and Wilcox and other types of water-tube boilers have been on the market. This, we think, has been within the past twenty-five years. E. F. McCABE.

E 3. What is the rate of evaporation per pound of fuel for return tubular and internally-fired marine-type boilers?

Horizontal tubular boilers built by a well-known firm hold a record of 12.86 pounds of water evaporated per pound of combustible from and at 212 degrees Fahrenheit.

W. W. TITZELL.

It depends entirely on the heat value of the fuel and the condition of combustion of the fire serving the boiler.

A. BEMENT.

The evaporation for horizontal return tubular boilers may be from 9 to 10 pounds of water per pound of coal burned, when high-grade anthracite or Cumberland bituminous coal is used and the firing is done with brains. With low-grade coal, the evaporation per pound of coal may be considerably less: and the result will also be less if the firing is poorly directed or the boilers are in bad condition or poorly set. Internally-fired boilers can not be relied upon to give any higher evaporation per pound of coal than can be obtained with proper firing of well-designed and properly-set return tubular boilers.

DUGALD C. JACKSON.

A well-set return tubular boiler should give an evaporative efficiency of nine to ten pounds of water from and at 212 degrees per pound of combustible. E. F. McCABE.

It depends upon kind of coal, fireman and load factor to such an extent that no general answer can be given.

R. N. KIMBALL.

E 4. Is a Scotch or water-tube boiler best adapted to operate an electric plant 16 hours daily, variable load?

Either Scotch or return tubular is preferable to water tubular of any make. W. B. ROLAND.

Water-tube boilers preferred. G. WILBUR HUBLEY.

We find the water-tube boiler the most satisfactory, on account of the small volume of water contained, which makes it possible to add boilers quickly and economically as the load increases. The circulation in the marine boiler is slow so that the bottom of the boiler is generally cold, unless a circulating pipe is put in. This creates unequal strains in the boiler, and leakage.

R. N. KIMBALL.

E 5. What experience has been had with spiral or other form of baffle plates in the tubes of water-tube boilers and feed-water heaters? Is their use an advantage or otherwise?

Baffle plates or dry pipes are a necessity in all boilers having small steam drums or contracted water surface for the disengagement of steam. Spiral or baffle plates within the tubes of feed-water heaters and water-tube boilers have not proved of any benefit, but are in almost all cases a detriment, and in some instances dangerous. W. W. TITZELL.

E 6. Has any member had experience with corrugated furnace internally-fired boilers, and if so, what are the results?

They are used extensively in the United States Navy and are giving good satisfaction. GEO. W. RICHARDSON.

We have four 250-hp, internally-fired boilers with corrugated fire-box. These boilers have been in use nine years, giving excellent satisfaction. There has not been a fire tube renewed, neither has there been a rivet replaced since they were purchased. These boilers have been operated at 150 pounds initial pressure.
E. B. GREENE.

E 7. What kind of burner should be used, and how should the boilers be built inside, to give the best oil combustion?

A checker brick wall should be constructed about two feet and a half from bridge wall, wall be removed and the grates bricked over all but about one-third through which the air mixes with hot oil gases. A. E. WALDEN.

A burner in which the oil is atomized by steam with furnace built with brick arch so that the first or extreme heat of combustion does not come in contact with the shell or tubes.
G. H. CUSHMAN.

E 8. What special features would be required in a furnace designed to burn Iowa block coal?

The important features would be to place the boiler at an ample height above the grate bars (about three feet six inches in the case of a horizontal tubular boiler) and to provide for an ample supply of air through the grate bars.

H. T. Hartman.

E 9. What is the best ratio of grate to heating surface in a wood-fired furnace, and how much wood is burned per square foot of grate area?

E 10. Give any records of experience you have concerning burning of coal in an electric-light plant at a rate exceeding 30 pounds per square foot of grate surface per hour.

With Murphy stokers we have found that we can burn anywhere from 40 to 70 pounds of coal per square foot of grate surface per hour. United Elec. Lt. Co.

Sixty-nine pounds of coal per square foot of grate per hour has, to the writer's knowledge, been burned in such service.

A. Bement.

In its Heine boilers the Denver Gas and Electric Company is constantly burning 30 pounds or more, with an evaporation of between 6 and 6.5 pounds water per pound of coal and a horse-power development a small percentage above the builder's rating. C. F. Haywood.

Have burned as much as 44 pounds per square foot of grate for 10 hours with 0.75-inch draft in back connection of a two-pass Babcock and Wilcox boiler. Grates had nearly 60 per cent air space. W. P. Hancock.

E 11. Are mechanical stokers recommended for small plants, of, say, from 100 to 500 horse-power? Of 2500 horse-power?

(a) No. (b) Yes. Geo. W. Richardson.

No; and it is an open question as to the actual benefit of stokers for large plants. W. W. Titzell.

Stokers are advisable if a low grade of fuel is to be used where the maximum boiler capacity is required, but will not show much, if any, advantage in labor saving at plants under 500 horse-power.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

It is not advisable to use stokers for small plants, but for large plants it is desirable, as a saving is effected in labor.

C. W. KOINER.

Our opinion would be that mechanical stokers are economical for almost any size of plant. UNITED ELEC. LT. CO.

Mechanical stokers are to be recommended in all cases for plants with capacity exceeding 1000 horse-power.

G. WILBUR HUBLEY.

Mechanical stokers are not to be recommended for plants that use less than 50 or 60 tons of coal per week, and they afford comparatively little advantage to plants that do not use over 100 tons of coal per week. They are ordinarily to be strongly recommended for use in plants using over 200 tons of coal per week.

DUGALD C. JACKSON.

The greatest saving occasioned by use of mechanical stokers is the saving in boiler-room labor, and liability of labor trouble. In most small stations the saving would not warrant the installation, but in plants of 2500-hp and over the conditions are usually favorable to labor-saving mechanical stokers, provided proper coal is available. E. J. BECHTEL.

I should not ordinarily recommend stokers for a plant of from 100 to 500 horse-power. On a plant of 2500 horse-power it is probable that their use would be warranted.

H. BOTTOMLEY.

We do not think it advisable to use mechanical stokers in a small plant, say from 100 to 500 horse-power. In this case the cost of labor would not be lessened any; interest, depreciation, maintenance and power required to operate the mechanical stoker, would, we think, more than offset any saving that might be made by its use. Besides, it is impossible to force a mechanical stoker-fed furnace as much as one fed by hand. In a plant of 2500 horse-power the question of labor would, in all probability, make it advantageous to use a mechanical stoker. E. F. McCABE.

Mechanical stokers are of little advantage in small plants and it is doubtful if they are of any special advantage in any plant not equipped with machinery to bring the coal to the boiler. A plant of 2500 horse-power ought to be equipped with mechanical stokers and coal-handling machinery.

I. E. MOULTROP.

E 12. Is there an actual saving in using stokers, irrespective of cost or quality of coal?

Yes. In large installations the saving due to less labor is more than in the increased efficiency. GEO. W. RICHARDSON.

Doubtful. They are being put in and taken out frequently. A certain builder of stokers has one in an eastern city where he has paid upwards of $5000 in first cost and repairs to keep it going. W. W. TITZELL.

Have found very little saving in fuel by use of stokers, but have found a large increase in the capacity of boilers to carry high load peaks. A cheaper grade of coal can be used.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

We have found stokers very economical and they have effected considerable saving for us. UNITED ELEC. LT. CO.

Yes. G. WILBUR HUBLEY.

Mechanical stokers applied to a plant that uses sufficient coal (say 200 tons per week and upwards) and in which suitable coal-handling devices are installed, afford a large saving in the cost of labor. They may also be relied upon to improve the evaporative economy produced in the boiler plant as compared with ordinary hand firing, though there is no improvement as compared with the highest grade of hand firing.

DUGALD C. JACKSON.

The greatest saving occasioned by use of mechanical stokers is in boiler-room labor. The stoker, however, should be selected carefully with reference to the coal available. E. J. BECHTEL.

There is no actual saving in using stokers, irrespective of cost and quality of coal. E. F. McCABE.

The chief advantage in the use of stokers comes in the saving of labor. I. E. MOULTROP.

E 13. (a) What is the gain from the use of mechanical stokers? (b) Is the efficiency of the boilers increased? (c) With stokers, can a cheaper grade of coal be burned?

Uniformity and reliability of stoking fires, and lower grade of coal can be used with advantage and economy.
G. WILBUR HUBLEY.

A cheaper grade of coal can ordinarily be handled with much less cost for labor in a plant using mechanical stokers than in a plant relying upon hand firing. In connection with this question, see the answer to E 12. DUGALD C. JACKSON.

About five tons per day in a plant using 100 tons per day. (b) Yes. (c) Yes. G. F. WILLARD.

(a) Reduced cost of labor.

(b) Efficiency of boiler increased, but not efficiency of boiler and grate as compared with best hand firing.
W. P. HANCOCK.

The efficiency of the boiler should be increased slightly by the use of stokers. They also materially reduce the labor in the fire-room and make available many of the cheaper grades of coal. When properly handled, they also reduce smoke.
I. E. MOULTROP.

A cheaper grade of coal can be burned with the use of mechanical stoker than with hand firing. E. F. McCABE.

E 14. What is the cost of repairs on various types of stoker grates, including repairs to brickwork, inside of furnace? In answering, state make and horse-power of boiler, make and surface of grate, and effective draft, whether draft is natural, induced or forced.

We have found with Murphy stokers on 300-hp Hazelton boilers with natural draft that repairs per year per boiler have been less than $10 each. UNITED ELEC. LT. CO.

E 15. (a) Do smoke-consumers burn the smoke or prevent the making of it? (b) Do they reduce the expense of running the boilers?

(a) Prevent the formation of smoke.
(b) Yes. W. B. ROLAND.

(a) Smoke when once formed can not be burned; they do not entirely prevent the making of smoke. (b) The expense is greater with than without them.

GEO. W. RICHARDSON.

It is a chemical impossibility to burn smoke (lamp-black). Its formation can be and is prevented by introducing jets of steam under the grates or into the furnace.

W. W. TITZELL.

So-called smoke consumers prevent smoke, or, in other words, cause better combustion and in consequence increase furnace efficiency and lower cost of operation.

G. WILBUR HUBLEY.

Smoke consumers both burn the smoke and prevent its formation. The statement that smoke can not be burned, has been passed along by one writer and another for such a length of time that people do not always think what it means. Observation will show that smoke is discharged from igniting coal at the firing line of a stoker, but in its passage over the fire by mixture with air, its carbon combines just the same as any other. A. BEMENT.

The effective smoke consumer should produce more perfect combustion, which should increase the efficiency of the boiler.

I. E. Moultrop.

Smoke consumers prevent the formation of smoke by furnishing the proper amount of air for perfect combustion, hence there is no smoke. W. H. Mills.

Smoke consumers do not burn the smoke, but they do, in a great measure, prevent the making of it. E. F. McCabe.

E 16. Is blowing flues with steam injurious to the tubes, and if so, in what way?

No, provided the steam pressure is 90 pounds or over. The flues should be scraped once a week in addition to the blowing.

J. D. Saunders.

No. G. H. Cushman.

No. Geo. W. Richardson.

If the tubes are blown while hot the steam is not injurious, but by blowing them while cold a crust of soot may soon be baked upon the tubes, which will insulate them from the flame.

The Edison Elec. Ill'g Co. of West Chester, Pa.

No, not if the boiler is warm. Boiler tubes should not be blown with steam when the boiler is cold as it will cause the tubes to expand and leak. C. W. Koiner.

Our experience has been that blowing tubes by steam is injurious, in many cases producing a soot enamel which is next to impossible to remove with the ordinary flue scraper.

Chas. H. Peters.

Yes; it forms sulphuric acid and causes external corrosion.

G. Wilbur Hubley.

We have blown flues this way every day for ten years without noticing any injurious results.

The Edison Elec. Ill'g Co. of Brockton.

No. W. H. MILLS.

No. AUGUSTA RY. AND ELEC. CO.

E 17. Is it better to expand boiler tubes with boiler full or empty?

I don't know that there is any advantage either way. I have expanded tubes with the boiler full and also with it empty, and never saw any advantage one way over the other.
CHAS. N. SHAW.

It is better to have the boiler empty, especially with sectional expander. Either may give good results if no sediment is between the flue and sheet; neither will if sediment prevents a metallic contact. C. E. BOWE.

Empty. GEO. W. RICHARDSON.

It makes no difference, but no hammering or calking should be done to any extent when the boiler is full of water, as the concussions will cause leaks in other parts of the boiler.
W. W. TITZELL.

Boiler makers do not hesitate to roll tubes with the boiler full of cold water, provided the type of boiler is one that can be rolled without entering it.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

If by this is meant simply expanding tubes previously expanded, but leaking, it is better to do this with boiler full; then go over any that weep, with boiler under low pressure. Expand until weeping stops, but do not go further, as unnecessary rolling takes the nature out of tube ends.
CHAS. H. PETERS.

It is better to empty the boiler when expanding tubes.
C. W. KOINER.

When empty. WM. WIATTE.

Empty. G. H. CUSHMAN.

We have never had any trouble on tubular boilers with tubes that have been expanded with the boiler empty.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

It is better to expand them while they are empty.

AUGUSTA RY. AND ELEC. CO.

If a water-tube, expand when boiler is empty; if a fire-tube, do the same. H. C. HALL.

E 18. Is there any other method in use giving successful results for keeping the external surfaces of tubes free from soot in a water-tube boiler of the Babcock type, than the ordinary method of blowing with steam or air (by hand)?

Feed the blower with dry sand while blowing.

G. H. CUSHMAN.

There is a patented device that is said to be very effective.

H. BOTTOMLEY.

Forced draft will tend to keep boiler surfaces clean.

AUGUSTA RY. AND ELEC. CO.

Use the broom. R. N. KIMBALL.

E 19. We have two boilers that we do not use; what is the best way to keep them in good condition—keep them filled with water, steam them once a month, or dry them out and let them remain so until we want to use them again?

Empty the boilers and clean same thoroughly inside and out, then, with handhole and manhole plates out, put about a scoopful of charcoal in a pan and put same on two bricks, to keep pan off shell; put this in the boiler, on bottom of shell, and burn the charcoal until the boiler is perfectly dry inside. Then close all openings, placing about a peck of lump lime in a box in tube before closing manhole. CHAS. N. SHAW.

One good way is to clean them out and fill them with water; another way is to empty the boiler, dry it thoroughly, place trays of quick-lime in the bottom and seal it as nearly airtight as possible. This is the method used in the United States Navy.

GEO. W. RICHARDSON.

If boilers are to stand a long time out of use, by all means dry them out.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Never leave a boiler full of water for any length of time, particularly if it has steel tubes. We have had several instances where the boiler was left full of water and inside of nine months the steel tubes were ruined by pitting. Distilled water is death to steel tubes. Open the boiler and dry it out. In laying up, blow off or empty it, close the blowoff and put in two or three gallons of crude petroleum. Fill full of water (run over), then let the water run out. The vaseline will protect the shell and tubes.

W. W. TITZELL.

Keep them perfectly dry and leave handhole and manhole plates off.

ANDREW F. HALL.

Idle boilers may be filled full of water when out of service or they may be drained of all water, dried out, and pans of lime put in the bottom to absorb any moisture that may be in them.

C. W. KOINER.

We would recommend drying out the boiler and keeping it dry.

UNITED ELEC. LT. CO.

I beg to quote instructions received from a prominent manufacturer of steam boilers:

"The worst feature to take care of is outside corrosion * * * run the water out before the boiler has entirely cooled off, leaving gauge cocks and blow-off valves open to give as much circulation of air as possible, and when cooled entirely off, close up all valves and allow it to remain that way * * * clean off all the soot possible * * * close damper and all doors tightly * * * throw some boards on the grates and spread about a barrel of unslacked lime on them to absorb as much moisture as possible."

This information related to a water-tube boiler, but should offer suggestions for any type. GEO. B. LAUDER.

Keep boilers full of water. G. W. HUBLEY.

Keep them full of water. WM. WIATTE.

Should think a good way to care for boilers that are to stand idle for any considerable length of time would be to clean and dry them thoroughly (leaving the manhole plates out) and set pans of lime inside the boilers and settings to absorb any moisture that may gather. O. H. YOUNG.

Use them at stated intervals. G. H. CUSHMAN.

It is better to lay away boiler dry. Disconnect steam and feed-piping or blank off with blind flanges. Drain boiler and put in pan of lime. Renew lime occasionally.

To put boiler away wet, put in five to 10 pounds of soda, according to size of boiler, and pump completely full of water. Soda-water will not corrode. F. D. ELWELL.

Dry them out, close all the valves and let them stand.
G. F. WILLARD.

Empty, take out manhole and mud-drum plates, and in water-tube boilers bottom-tube caps, and keep boilers dry.
W. P. HANCOCK.

Keep them in working condition by occasional use in actual service; boilers deteriorate rapidly if idle; if used occasionally you know they are in good order and ready to help out in case of emergency. H. BOTTOMLEY.

Unless feed water is exceedingly good, it is best to steam the boilers at least once a month.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Keep the boilers dry all the time.
AUGUSTA RY. AND ELEC. CO.

Fill the boilers with water and put in two or three quarts of kerosene; warm up and then blow down dry. This gives the boilers a slight coating of oil, which protects them from rust, and also loosens the scale. W. H. MILLS.

Dry them out and place a tray containing five pounds of quick-lime inside the boiler; close up the manhead and leave water columns open to give vent. J. D. SAUNDERS.

E 20. Supposing a boiler fire had been banked, and, bank becoming hot, pressure had risen; also that safety valve had stuck and pressure on a 100-pound boiler was found to have run up to, say, 175 pounds, would the sudden opening of safety valve be attended with any disastrous results?

It would not be advisable to let the safety valve open, although it would be hard to say what the results would be, as the factor of safety is generally taken at five. A better way would be to cover the bank with ashes and then in a few minutes put the pump on; this would reduce the pressure gradually.
GEO. W. RICHARDSON.

Better not try this experiment unless you want to risk death. Stop the heat by covering or smothering the fire with wet earth or ashes, opening the damper, and let the boiler cool off slowly. If the chimney draft is strong then open the damper very little, as the cold air is liable to cause too sudden contraction of tubes, which might result in leaks.
W. W. TITZELL.

Under the condition assumed it would be well not to open the valves, but rather to diminish the fire by drawing it or covering it with wet ashes. C. W. KOINER.

Such an occurrence would probably be disastrous.
G. WILBUR HUBLEY.

It would be liable to be disastrous. Cover fire with wet ashes and leave safety valve alone. WM. WIATTE.

Under the circumstances suggested in this question, the safety valve should never be touched. A safe method to let off pressure would be to bank the fire heavily with green coal and blow off very gently through blow-off pipe.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Possibly. I would suggest letting the steam out gradually through some other opening.

AUGUSTA RY. AND ELEC. CO.

If there were three gauges of water, the sudden opening of the valve would be liable to rupture the boiler by water-hammer.

H. C. HALL.

It sometimes proves disastrous; not always.

J. S. ROBINSON.

It might cause an explosion. It would be better to cover fire with ashes and let the boiler cool down. F. W. BULLOCK.

E 21. Operating three boilers loaded at peak, is it economy to cut off one and bank when load falls within capacity of two?

Certainly. GEO. W. RICHARDSON.

It will depend upon how fast the load falls after it comes within the capacity of the two remaining boilers. Ordinarily it will save fuel to keep the fire under the extra boiler burning with individual damper closed until furnace is cooled down. It is also poor policy to bank a fire when furnace is very hot, if it can be avoided.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Have tried both ways, and find that if you have good dampers and a number of hours to run you can save by banking.

ANDREW F. HALL.

It is better to cut out one boiler when the load drops off to that point where two will do the work without crowding.

C. W. KOINER.

Yes. G. WILBUR HUBLEY.

Not until the load falls to a point where the two will handle the load with ease. WM. WIATTE.

Yes; if the two in use are not worked hard enough to throw water. C. F. HAYWOOD.

If in a lighting plant and the boiler is to remain idle for 16 hours or over, cut it out and bank fire. J. D. SAUNDERS.

Yes. W. P. HANCOCK.

Yes. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

A few trials will demonstrate which is the more economical, but it usually pays to load boilers up to the limit.
AUGUSTA RY. AND ELEC. CO.

This depends upon what is termed capacity of boiler. Efficiency falls very fast when rate of evaporation falls below two pounds per square foot of heating surface. J. S. ROBINSON.

A question of local conditions, quality of coal and amount of grate surface. R. N. KIMBALL.

E 22. Has any one tried the storage of heat or steam in a large boiler plant by banking all the fires but one and supplying steam from that one to maintain pressure in the idle ones, and if so, what were the results?

It is unnecessary to try it as the water in the boilers that are idle will not keep as hot as the temperature of the steam from the supply boiler; as there would be no circulation of the water in the dead boilers, the dead ones would act as condensers of steam from the live one. Then, again, the expansion of the top half of the boiler would be more than that of the bottom. It is not so much a desire to have the pressure of a boiler at all times as it is to have the temperature of the brick setting up to its working temperature. GEO. W. RICHARDSON.

In such case the boilers with banked fires would act as condensers. W. W. TITZELL.

Have found it economical in the management of battery boilers on a light day load to have the fires lightly banked in such a manner that a boiler will make some steam and pull the load principally with one boiler if it will do it without crowding. Fuel can be saved in all such cases by this means, but in no case work the boiler having the live fire with a strong draft.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

We tried this method with the following results: We bled our steam heads back into the boilers by means of two-inch pipe. This pipe goes into each boiler, with valve near entrance. The valves on two boilers being open and the pop valve on idle boiler blowing off before that of the forced boiler, we found the water nearly all lifted out of the boiler under fire into boiler banked. After this we decided not to continue the experiment.

A. PETERS.

Yes, have tried it, but have found that it is not economy, since the steam required to maintain pressure in idle boilers is wasted. WM. WIATTE.

Yes; I have made several tests of this and always at a loss of fuel. J. D. SAUNDERS.

The boiler condenses the steam from the others to keep it hot and requires the water to be blown down frequently.

W. H. MILLS.

E 23. What is the principal cause of and remedy for rapid deterioration in axles and wheels of gravity-bucket continuous coal-and-ash conveyor systems?

The manufacturer will tell you not to oil them, but experience has proven that a swab and a bucket of black oil occasionally will increase their life 50 per cent or more.

GEO. W. RICHARDSON.

When new, paint with three coats of Dixon's graphite paint. The metal must be perfectly clean before painting. All scales of rust must be removed. Each coat should be allowed to dry before adding another. This paint will resist sulphuric and diluted acid. W. W. TITZELL.

Dirt. W. P. HANCOCK.

Probably sulphuric acid and grit.
AUGUSTA RY. AND ELEC. CO.

Corrosion due to formation of sulphuric acid from the sulphur from coal and ashes. G. WILBUR HUBLEY.

E 24. What is the smallest amount of grate surface, measured in square feet per kilowatt, required to produce the amount of steam demanded at the time of the peak of the load?

The smallest amount of grate per kilowatt should be 0.12 square foot. W. P. HANCOCK.

This would depend on the intensity of draft, as it is necessary to burn an increased amount of coal in order to obtain an increased amount of heat. The more favorable the conditions, the less amount of coal required. The question would imply a very uneconomical use of coal and it is not advisable to experiment in this direction, either from the standpoint of efficiency or repairs to boilers, which are necessarily bad under intense draft. H. T. HARTMAN.

This question should have included some data giving type of equipment of plant for which answer is desired. The grade of coal used and the efficiency of boilers, engines and generators, would have to be known in order to arrive at anything like an approximate conclusion. The amount of steam used per kilowatt-hour would have to be found, after which all would depend on the efficiency of the boiler with grade of coal used. Enough coal would have to be burned to evaporate the amount of steam required per hour, and enough grate surface would have to be provided to burn that amount of coal at a rate not to exceed 25 or 30 pounds of coal burned per square foot of grate per hour. In connection with the above it may be of interest to those who have not noticed the fact, that one boiler-horse-power (centennial standard) is about the right size for one kilowatt output with compound-condensing engines, and the necessary steam auxiliary equipment, under average conditions. The grate area furnished with a water-tube boiler of about 500-hp size would be from 0.16 to 0.22 square foot per rated horse-power of boiler.

J. A. MALONEY.

E 25. Are there any furnaces for burning bituminous coal that are absolutely smokeless?

Yes, there are furnaces for burning bituminous coal that are absolutely smokeless. A. BEMENT.

With intelligent operation a number of well-known furnaces on the market should meet the requirements in regard to the absence of smoke. I. E. MOULTROP.

The Murphy or Roney stokers will burn coking bituminous coal continuously without making smoke. The Babcock and Wilcox chain grate will burn free-burning coal continuously without smoke. The cleaning of the Murphy or Roney stokers has to be done carefully if this result is to be obtained. The Babcock and Wilcox chain grate is (with most fuels) self-cleaning. The result will be more certain if the boilers are raised two feet or thirty inches higher above the furnace than is customary; the effect of this being to give a larger combustion chamber: A "Dutch oven" hand-fired furnace in which the arch extends over the entire length of the grates can be operated smokelessly under a reasonably steady load if it is equipped with sectional grates that can be shaken and cleaned a small part at a time. No furnace whatever can be operated absolutely without smoke if (a) the load is subject to great variation; or (b) if in order to clean fires the furnace must be cooled.

THE EDISON ILL'G CO. OF DETROIT.

There is more or less smoke with all forms of furnaces for burning bituminous coal. H. T. HARTMAN.

None that I know of that are commercially possible. A good under-feed stoker will give almost no smoke. Also, a hand-fired boiler with fire-brick arch will give very little smoke if the fireman keeps his fire thin and well spread, and uses the one-shovel method of firing. A. BALSLEY.

E 26. In a central station having an annual output of about 2,000,000 kilowatt-hours, what figure would represent good practice in boiler-room labor per kilowatt-hour, coal and ashes being handled by hand?

Two-tenths cent per kilowatt-hour is a fair figure for boiler-room labor for non-condensing stations having an annual output ranging from 1,500,000 to 2,500,000 kilowatt-hours. This is an average of several plants that were operated in Chicago some few years ago, burning No. 1 Illinois nut.

A. L. LANDSBERG.

From 0.15 to 0.18 cent per kilowatt-hour.

H. T. HARTMAN.

Type of boiler equipment and load factor have so much to do with central-station costs per kilowatt-hour that it is hard to give exact data without this information. With average equipment and the ordinary load factors the costs will be close to two mills per kilowatt-hour.

THE PHILADELPHIA ELEC. CO.

One-tenth of a cent. FRED B. SHARPE.

E 27. Is there any efficient apparatus on the market for directly determining the percentage of CO_2 in the waste gases passing from the boiler?

The econometer, gas composimeter, dasymeter, Ados apparatus—are all automatic and continuously-indicating instruments. The chemical econometer and Orsat apparatus are simple chemical instruments, but require personal manipulation. All of these devices are good and efficient. The Orsat apparatus is much the lowest in cost and is to be recommended in the very large majority of cases, because the other instruments require a little care and attention, and in a plant where condition of combustion and furnace performance has only occasional attention, they suffer neglect and so get out of proper condition—through no fault of the instrument, but owing to neglect. It is less expensive to let a $25 instrument go to the scrap heap than one costing $150 to $300. A. Bement.

The Orsat apparatus will determine the amount of CO_2 in the flue gas within one-tenth of one per cent. Sam'l Kahn.

There is a device for directly determining the amount of CO_2 in the flue gases of a boiler. H. S. Russell.

The Orsat gas-analysis outfit. W. P. Hancock.

E 28. What is proper mixture for filling fusible plugs in boilers carrying 110 pounds steam? Plugs are protection against low water.

Some machinists use pure tin. Fred H. Beck.

Pure Banca tin. E. W. Furbush.

E 29. Does a clean, smokeless chimney in itself possess a money value through its effect on the community? In other words, does it represent a value other than possible saving of fuel to the owner?

A smokeless chimney has a money value if it is a part of a system that expresses the same thought of care and cleanliness throughout. Augusta Ry. and Elec. Co.

It is possible that it may have a "nuisance value," but it would naturally be difficult to determine. H. T. Hartman.

In addition to the possible saving of fuel, a smokeless chimney would effect a great saving in painting bills. The buildings in the immediate vicinity of one of these smoky chimneys have to be painted about once in two years, or three years at the most, and even then they never look to their best advantage. We also find considerable difficulty from having the smoke and soot deposited on the limestone trimmings of our buildings. This, of course, produces a discoloration that is more or less permanent. There is undoubtedly a saving of fuel in the majority of cases, but the money invested to effect that saving is so great that it is very difficult to prove, even taking into account the painting bills, that it is a good investment for the owner. WALTER FLINT.

F

FORCED DRAFT, BLOWERS AND STACKS

F 1. Which is the more economical system—forced or induced draft? Why?

Forced draft, for the following reasons: Less power to operate, because of smaller volume of gas; less maintenance and depreciation, because gases are cool and free from sulphur compounds; less leakage in boiler settings, because of less difference of air pressure between gas passages in boiler and atmosphere, with a given difference of pressure below and above the grate.

J. S. AVERY.

There is more economy in induced draft than in forced, because of the fact that in the latter there is always a tendency, unless with under-feed stokers, to blow holes in the fire, resulting in uneven combustion. Other factors that would enter into the question of preference more strongly than economy are adaptability, maintenance and cost of installation. E. E. LEE.

It depends upon circumstances. Induced draft requires no power, but considerable investment in a good chimney.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Forced draft—air delivered under the grate bars at a pressure from one inch to one and one-half inches of water. Induced draft takes away a portion of air from above the fire, which is needed for complete combustion of the gases. Air under the grates protects them and tends to dissolve the clinkers. We have taken coal that formed bad clinkers under natural draft, but with a pressure of air (one inch of water) in the ash pit, the same coal was burned without forming any clinkers whatever.

W. W. TITZELL.

Forced draft. G. WILBUR HUBLEY.

The Denver Gas and Electric Company has been using forced draft with great success, thinking it better than induced.

C. F. HAYWOOD.

Forced draft. The air becomes heated before passing through the coal. G. F. WILLARD.

This depends entirely on local conditions. For an old plant, forced; usually induced draft for new plant. Partly because the induced draft does away with the necessity for a stack.

AUGUSTA RY. AND ELEC. CO.

Under forced draft air is forced through the fire, the pressure above the atmosphere being maintained either in the closed ash-pit or in the closed fire-room; the latter arrangement is practical only in marine service.

Under the induced or suction method the products of combustion are exhausted from the furnace, a partial vacuum is produced therein and air thereby caused to flow through the fuel. Both systems, however, operate to produce a pressure difference between the ash-pit and the combustion chamber, and, other things being equal, there is no conclusive evidence that one method is superior to the other; the one to be adopted must depend upon conditions, and the advantages as compared with chimney draft are common to either.

C. C. GARTLAND.

F 2. How much can the capacity of a battery of boilers be increased by the use of induced draft or forced draft?

Fifty to 100 per cent, but it is not to be considered as a regular thing for economical operation. A. E. WALDEN.

About 100 per cent by forced draft.
G. WILBUR HUBLEY.

About 25 per cent. AUGUSTA RY. AND ELEC. CO.

F 3. Is there an actual gain in using forced or induced draft over natural draft, with grate and heating surface properly proportioned for forced draft?

Have never found any advantage in forced draft.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Yes; it permits of burning far more coal per square foot of grate and, to that extent, of overloading boiler.
AUGUSTA RY. AND ELEC. CO.

Yes. W. W. TITZELL.

Yes. A. E. WALDEN.

No, it is not economical. G. WILBUR HUBLEY.

In some particular cases, there is actual and positive gain in the use of forced as compared with induced draft by either fan or chimney. For example: with a stoker, suction draft may be so strong as to cause such an inflow of air through the coal in the hopper as to prevent its igniting, but with air forced under the grate, a much higher pressure may be used than is possible with suction draft. A. BEMENT.

F 4. Is mechanical draft desirable for one 60-inch by 16-foot fire-tube boiler, worked intermittently?

It would not be advisable to use mechanical draft under the condition stated. C. W. KOINER.

Would not consider mechanical draft under such conditions.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

No, excepting when the wind is not in the right direction or you happen to get an extra bad grade of coal.
GEO. W. RICHARDSON.

No. G. WILBUR HUBLEY.

No. AUGUSTA RY. AND ELEC. CO.

F 5. Which is the better practice in a station of 600 horsepower—to use forced draft and economizers, or to have a good chimney?

Good chimney desirable. G. WILBUR HUBLEY.

Can see no objection to good chimney draft with economizers. Forced draft is not an economical process of burning fuel. W. B. ROLAND.

Should prefer chimney.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

For a plant of this size natural draft with economizers would be a very economical arrangement.
C. W. KOINER.

A good chimney, if the price of material and labor is not too high for installation. GEO. W. RICHARDSON.

To use forced draft judiciously; but it is harder on the boilers than when operated by natural draft. The best way is to have ample boiler capacity so that 0.75 inch of water with fan under grates would be sufficient. W. W. TITZELL.

A good chimney can always be relied upon, unless the conditions are unusual; and it is to be preferred to forced draft in a station of the size named in the question. Economizers may be used in connection with the chimney if the boilers do not have sufficient heating surface to reduce the gases to the lowest temperature compatible with good draft.
DUGALD C. JACKSON.

Have a good chimney. (UNSIGNED.)

The best practice in the majority of cases is to let nature do the work with the aid of a good chimney. In the design of power installations, the merits of the various systems of mechanical draft should be figured out with reference to the existing conditions and the following points brought into consideration:

(1) The gain due to lowering the temperature of the flue gases.

(2) The gain due to the use of an economizer.

(3) The theoretical gain of forced draft effected by the use of a less quantity of air per pound of fuel consumed and consequently less heat wasted in raising the temperature of that air.

(4) The quantity of fuel required to be burned in a given time and the total amount of air needed for complete combustion.

(5) The fact that natural draft will not easily burn more than 25 pounds of average coal per square foot of grate.

(6) That an economizer, as usually designed, diminishes the draft by about 30 per cent.

The simplest comparison that can be made, is to add together the interest on the first cost, including the housing, ground rent, coal and attendance, and divide this sum by the pounds of water evaporated. Keep in mind the respective durability of the different types of plant. WM. MCDONALD.

With a large steady load and intelligent care the forced draft and economizer, or induced draft and economizer, would be better. AUGUSTA RY. AND ELEC. CO.

In a station of 500 horse-power, we think it better engineering practice to have a good chimney than to use forced draft and economizers. E. F. MCCABE.

Forced draft and economizer. H. C. HALL.

Forced draft and economizers would be more efficient in operation. An estimate of economy includes, however, the factor of fixed expense, excess of which with forced draft and economizer may be greater than saving in efficiency gained by their use, especially where we can economize on only a fraction of the load provided for. I. S. Robinson.

F 6. Has any one tried an all-concrete stack, or a concrete stack base with smoke flue entering the concrete, without having same lined with fire-brick? If so, what has been the result?

If stack base is made of good cinder concrete, there should be no trouble if not lined with fire-brick.

The Edison Elec. Ill'g Co. of West Chester, Pa.

Experience of others has shown it to be successful.

G. Wilbur Hubley.

We have had an all-concrete smoke tunnel and stack base in use over six months with very satisfactory results.

P. H. Korst.

In a recent article in *Cement Age*, written by a German engineer, he brought out the fact that hot gases had a deteriorating and disintegrating effect on concrete. If this be true an all-concrete stack would not be much of a success, unless it were lined. E. F. McCabe.

F 7. What is the minimum allowable height for the lining of self-supporting steel stacks?

Chicago, Ill., ordinance calls for a brick lining not under 38 feet in height. Geo. W. Richardson.

One-third of height. G. Wilbur Hubley.

We have a stack of the self-supporting type, 100 feet high, that has been in use for a number of years, that never had a lining in it, and I have used others that were operated under the same conditions and never gave the least bit of trouble.

G. B. Leland.

The minimum height of the fire-brick lining should be at the point where the action of the hot gases will cease to affect detrimentally the shell of the chimney.

Example: Assuming the following data:

Chimney height = 150 feet.
Temperature = 400 degrees Fahrenheit.
Atmosphere temperature = 60 degrees Fahrenheit.
Temperature that may be used next to chimney plates = 150 degrees Fahrenheit.

The height of fire-brick lining may be calculated as follows:

Maximum difference in temperature between flue and atmosphere = 400 degrees — 60 degrees.
= 340 degrees Fahrenheit.
Degrees that temperature is lowered per foot rise of chimney = 340 degrees ÷ 150 feet
= 2.23 degrees Fahrenheit.
Difference in temperature between flue and the exposed portion of inside shell at the point where the fire-brick lining terminates = 400 degrees — 150 degrees
= 250 degrees Fahrenheit.

Then 250 degrees ÷ 2.23 degrees gives 112 feet as the height of fire-brick for this particular case.

Wm. McDonald.

F 8. What is the value of mechanical-draft apparatus as an auxiliary means for producing excess boiler capacity during peak of the load?

About 25 per cent of full load.

Augusta Ry. and Elec. Co.

For obtaining extra boiler capacity during peak loads, or in case of emergency, steam blowers applied to each boiler are simply invaluable, especially in view of their low first cost, small amount of space required, and simplicity of operation. The question whether the expense of a mechanical draft plant would be warranted would depend on each individual case.

H. T. Hartman.

Auxiliary mechanical draft *versus* additional boiler equipment may be warranted if the peak is of very short duration. The vital point to consider in this connection is the margin of extra capacity needed to insure absolute reliability of service.

Auxiliary mechanical draft *versus* additional stack investment is a more common phase of the question, and if installed would ordinarily be used and controlled the same as natural draft. THE PHILADELPHIA ELEC. CO.

Good, if you baffle boiler and install damper regulator.
FRED B. SHARPE.

G

PIPING, CONDENSERS, ETC.

G 1. What is the best gasket material for steam headers carrying superheated steam at 175 pounds pressure?

Corrugated copper discs. GEO. W. RICHARDSON.

I have found that sheet asbestos treated with cylinder oil and graphite gives good satisfaction. J. D. SAUNDERS.

The McKim gasket. This gasket is made into a copper ring with a core of rubber or asbestos. C. W. KOINER.

Asbestos board saturated with boiled linseed oil and rubbed over on both sides with Dixon's flake graphite. Such joints are everlasting; we have never known one to blow out.
W. W. TITZELL.

Asbestos. WM. WIATTE.

This is largely a matter of opinion. Continental practice, with long experience with high-pressure superheated steam, has proven copper under certain conditions to be unsatisfactory on account of the high temperature, and pure asbestos—also previously much used—is blown out by the high pressure. For these reasons corrugated copper or wire gauze imbedded in asbestos or graphite has been used extensively. Soft iron or steel gaskets, also iron-to-iron joints, are used; the latter are commonly used in the prominent plants of New York. FRANZ KOESTER.

I have found annealed, corrugated-copper gaskets to give best results; but care is necessary in having all jointing surfaces match very fairly and be rather smooth. There are also two or three soft sheet packings, having a large percentage of very fine iron dust in their composition, which do well under the conditions referred to in the inquiry, but the sheet must be very thin, the joint surfaces rather rough, and the joints followed up carefully two or three times during the first day or so after heating up. These joints are hard to break and clean after having become rusted in, whereas the corrugated gaskets are easily removable and if carefully cleaned and reannealed can be used again.

C. F. HEWITT.

Corrugated-copper gaskets. R. N. KIMBALL.

A metallic gasket that is reasonably soft and does not quickly crystallize should give good results.

I. E. MOULTROP.

Asbestos sheet is being used successfully on steam pipes up to 18-inch diameter, 160 pounds pressure, 150 degrees superheat, where the various corrugated-metal gaskets failed, owing to flanges being slightly sprung. J. T. COWLING.

G 2. What kind of gaskets are the best to use under the bonnets of 8-inch to 16-inch steam valves, operating under 180 pounds pressure, with 150 degrees superheat?

Gaskets cut from 12 or 16-ounce copper, just large enough to lay inside the studs, well annealed and painted with graphite paint, will make a satisfactory joint if the bonnets are properly proportioned.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

The McKim gasket. C. W. KOINER.

See answer to G 1. FRANZ KOESTER.

See answer to G 1. C. F. HEWITT.

See answer to question G 1. I. E. MOULTROP.

G 3. What has been found to give best results for making and keeping flange joints tight on steam pipes with a pressure of 150 pounds or more, with saturated or superheated steam?

See answer to G 1. C. F. HEWITT.

The McKim gasket. C. W. KOINER.

Gaskets cut from 16-ounce copper, well annealed and painted with graphite paint, just large enough to lay inside the bolts, will make a permanent joint in any flange that has been properly faced, if the flange is heavy enough and provided with sufficient bolts. THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Rainbow packing is satisfactory. G. WILBUR HUBLEY.

Same as G 1. We have used these joints in our practice since 1883, and never had one fail. W. W. TITZELL.

Copper gaskets properly made up with a red-lead paste, and care taken to see that the flanges were faced and lined up so that they would come together without putting a strain on the flange. G. B. LELAND.

See answer to G 1. FRANZ KOESTER.

Cut a gasket from one-sixteenth-inch asbestos sheet, soak in water, place between the flanges and draw up tight.
DAVID W. BEAMAN.

With satuated steam under the conditions given, corrugated-copper gaskets will give good results. Under superheated steam a properly made ground joint should give satisfaction.
I. E. MOULTROP.

Ebonite sheet packing. Under our conditions steam is occasionally shut off the header, and copper gaskets leak. We have never had trouble with saturated steam at 150 pounds packed with ebonite. R. N. KIMBALL.

G 4. What are the advantages and disadvantages of using globe valves with metal discs and seats on a steam main from 6 to 12 inches in size; steam pressure 150 pounds, with 100 degrees or more superheat?

The metal disc of a globe valve from six to 12 inches for 100 degrees superheat (pressure may be ignored) may be durably made of a bronze alloy. On the continent of Europe, where for some time 300 degrees and more of superheat have been used, the entire valve, including the disc and stuffing-box coming into direct contact with the steam, is constructed of cast-iron or special steel. FRANZ KOESTER.

G 5. What is your opinion of the use of spiral-riveted, galvanized pipe for exhaust between engine and condenser?

Too many chances for punctures and leaks when running on high vacuum. GEO. W. RICHARDSON.

Not suitable. Liable to leak, and not good enough from a mechanical point of view. C. W. KOINER.

Would recommend cast-iron pipe between engine and condensers and spiral-riveted galvanized-iron pipe for atmospheric exhaust. G. WILBUR HUBLEY.

It is too uncertain, too light, liable to leak. This pipe should be more substantial. The only reason for using this pipe is to reduce cost, but at the risk of considerable loss.
W. W. TITZELL.

It will work all right and will be much cheaper than cast-iron. G. B. LELAND.

My experience has been that the use of spiral-riveted pipe for the purpose mentioned is very objectionable on account of the tendency to air leakage caused by the solder at the seams rotting, apparently caused by the action of the oil in the exhaust steam. C. F. HEWITT.

It should not be used. H. BOTTOMLEY.

We have found short sections of spiral-riveted pipe satisfactory. AUGUSTA RY. AND ELEC. CO.

Spiral-riveted galvanized pipe joints would not be the proper material for use under vacuum. It would be a very difficult matter to stop air leaks should they occur.
I. E. MOULTROP.

G 6. Has any trouble been experienced, from electrolysis or otherwise, in the use of iron fittings in connection with brass pipe for boiler-feed lines?

Cast-iron elbows are very satisfactory for this purpose. Brass and malleable iron are not so good on account of galvanic action. W. W. TITZELL.

In our experience iron fittings in brass hot-water boiler-feed lines pit out and are unsafe. The object of the brass pipe being to secure reliability in this important line the extra expense of brass fittings is certainly warranted by the results.
THE PHILADELPHIA ELEC. CO.

G 7. A prominent boiler insurance company advocates placing the check valve before the stop valve in the boiler-feed connection to main water line. Would it not be better practice to reverse this arrangement?

No matter what he advocates, the proper place for the stop valve is nearest the boiler. GEO. W. RICHARDSON.

Stop valve should be next to the boiler to permit taking check valve apart for cleaning or repairs. C. W. KOINER.

Have operated boilers a number of years with checks before stop on some boilers and back of stop on others, and can see no reason to favor either method, as one works as well as the other.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Place valve next to boiler, then check outside this. If any refuse should get under check you can close boiler off and remove it; if check is placed next to boiler you can not do this.

A. PETERS.

Check valve should be between stop valve and boiler.

G. WILBUR HUBLEY.

This should never be done, for the reason that if anything happens to the check it could not be shut off and repaired without blowing off the boiler. The United States inspectors would not permit this; the valve should be reversed, *i. e.*, the stop valve next to the boiler. W. W. TITZELL.

Think the boiler insurance company's idea is right in regard to placing the check valve before the stop valve.

O. H. YOUNG.

A check valve should be placed between boiler and stop valve; the check should also be a stop valve.

THE COLORADO SPRINGS ELEC. CO.

Use one before and after so as to be able at any time to examine check valve. G. H. CUSHMAN.

Yes. G. F. WILLARD.

No; because if the check should get hung up or become clogged it could not be inspected without a stop valve between it and the boiler. In practice I should prefer having a stop valve on each side of the check, as I have often found checks clogged with plunger packing from the pump; by having the valves placed in this manner it would be necessary only to shut off the feed of one boiler while the check is being fixed. J. D. SAUNDERS.

Place a stop valve on each side of the check; keep the one on the boiler side wide open and use the other to regulate the water flow. H. BOTTOMLEY.

We use stop valve on each side of our check valve.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

The check valve needs attention more often than the valve, so the proper place for the valve is next to the boiler, then the check valve. W. H. MILLS.

Better practice is to place stop valve between check valve and boiler. H. C. HALL.

G 8. Is it as necessary to drip steam mains carrying superheated steam as those carrying saturated steam?

All steam mains should be provided with means for draining off the water of condensation. C. W. KOINER.

By all means provide for drips.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Would advise careful draining of steam mains under all conditions of steam temperatures, as the mechanical entrainment of water is about as likely to occur in superheated steam as in steam moderately saturated. C. F. HEWITT.

Yes, always. W. W. TITZELL.

Yes. G. F. WILLARD.

No. J. F. DOSTAL.

On the continent of Europe modern practice tends to eliminate all drips and water-catchers in front of the engine by increasing the degree of superheat. This, of course, applies only to the highest degrees of superheat—300 degrees or more.

In this country, as well as in England, where the use of superheated steam is not very common and where, when it is

used, the degree of superheat is only about 150 at the boiler, it would be advisable to supply the steam main with at least one reliable water-catcher close to the throttle. It may be interesting to note here that the drop in temperature of steam is from one to four degrees per foot of bare pipe, depending, of course, upon the diameter of the main and the velocity of the steam.
FRANZ KOESTER.

Yes, because when no steam is flowing condensation will ensue.
W. P. HANCOCK.

It is very desirable to install a drip system on a superheated steam plant. In warming up the pipe there is a good deal of condensation to be taken care of and cases have been known where water has been carried through the superheater and into the pipe.
I. E. MOULTROP.

Yes.
H. BOTTOMLEY.

It is customary to drip mains carrying superheated steam.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

G 9. Modern practice tends toward the use of smaller steam lines. What velocity of steam should be used in designing same?

Six thousand feet per minute.
GEO. W. RICHARDSON.

About 6000 feet per minute.
A. PETERS.

In Germany, where small pipes originated, due to the extensive use of superheat, velocities as high as two miles per minute are employed, while in this country velocities are in the neighborhood of one mile per minute.
FRANZ KOESTER.

The velocity of steam may be figured at 6000 feet per minute.
SAM'L KAHN.

Six thousand to 7000 feet per minute under normal operating conditions.
I. E. MOULTROP.

Six thousand feet is good practice. H. Bottomley.

G 10. (a) What formulas should be used for diameters of steam pipes in a large electric-power plant using steam at 160 pounds pressure? (b) What drop in steam pressure would you allow in a run of 100 feet? (c) What rule would you use for proportioning the exhaust pipe leading to the condenser, the distance being 50 feet?

Steam lines

$$d = D\sqrt{\frac{s \times r.p.m.}{36000}}$$

Exhaust lines

$$d = D\sqrt{\frac{s \times r.p.m.}{24000}}$$

d = internal diameter of steam pipe in inches.
D = diameter engine bore in inches.
s = stroke of piston in inches.
r.p.m. = revolutions per minute.
Nine or 10 pounds drop. W. B. Roland.

Steam at 160 pounds gauge equals 175 pounds absolute, and the volume of a pound of steam at this pressure equals 2.562 cubic feet.

Suppose, for example, it is required to find the diameter of a steam main that is to convey 12,000 pounds of steam per hour, at 160 pounds gauge or 175 pounds absolute, assuming the velocity of steam is not to exceed 6000 feet per minute. The volume discharged per minute is $\frac{12{,}000 \times 2.562}{60}$ cubic feet and the required area of the pipe is $\frac{12{,}000 \times 2.562}{6000 \times 60}$ square feet = $\frac{12{,}000 \times 2.562 \times 144}{6000 \times 60} = 12.9$ square inches or the minimum diameter is four inches.

The diameter to be adopted is always something above the minimum; probably in this case five or six inches, depending upon the length and bends. Geo. W. Richardson.

G 11. What has been the experience with painting in different colors, and stenciling near valves, steam, water and other pipes, as in marine practice, especially as for guidance of the men and increasing the reliability of plant?

Certain parts of the installation should have valves labeled in some way so that there would be no confusion in the operating by training green men. The pipe system should not be so complex as to make it necessary to use different colors to identify the various systems. I. E. MOULTROP.

This is an excellent plan, and in view of its advantages in breaking in new men and in times of emergency it is surprising that it is not more generally adopted. H. T. HARTMAN.

G 12. Do you advocate a heater between engines and condenser when two or more engines are piped to one condenser?

No. The amount of heat gained would be in the neighborhood of 100 to 120 degrees and it would be better to heat feed water with steam from auxiliaries or economizers.
C. W. KOINER.

Yes. GEO. W. RICHARDSON.

Yes. J. F. DOSTAL.

Yes. I. E. MOULTROP.

Yes. AUGUSTA RY. AND ELEC. CO.

Yes. H. W. MILLS.

G 13. What are the advantages of a Holly steam loop over a steam-driven receiver pump?

It is better to use a steam trap and return the water of condensation back to feed tank. My experience with the loop resulted in substituting a steam trap for same, because of inability to keep the check valves from hammering themselves to pieces owing to the pulsation of the steam in the header.

GEO. W. RICHARDSON.

Economy and reliability, and less cost of maintenance.

G. WILBUR HUBLEY.

It is more economical, when properly designed and erected. It is very delicate and the conditions must be just right to realize satisfactory results. W. W. TITZELL.

It requires less care to operate, and is more reliable.

G. B. LELAND.

Ease and certainty of operation. W. P. HANCOCK.

The Holly system requires less attention and less repairs than the steam-driven reserve pump. It is supposed to be somewhat more reliable. I. E. MOULTROP.

With a Holly system of steam loop, you install it and then forget it, for it practically needs no attention; with a steam-driven receiver pump, you install it and then keep everlastingly at it, because it needs lots of attention. H. BOTTOMLEY.

The Holly steam loop is cheaper to operate.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

The Holly system when once started rarely needs attention, while a steam-driven pump and receiver needs attention all the time. H. C. HALL.

G 14. Which is considered the best practice as regards the disposition of exhaust steam from air pumps—to turn it into the condenser, into the air through a heater, or into the engine receiver?

If you can condense the exhaust steam from the air pumps, by all means put it there.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Into the condenser; but in a large plant it is sometimes advisable to have an auxiliary condenser. See answer to question C 7. GEO. W. RICHARDSON.

If exhaust for heater is limited, the best practice would be to use exhaust from condensers to make up deficiency; otherwise, pipe exhaust into condenser. G. WILBUR HUBLEY.

Into the condenser, always. W. W. TITZELL.

If there is sufficient heat from other sources to heat the feed water, or economizers are in use, it would be best to turn the exhaust from the air pumps into the condenser; otherwise, it would be better to put the exhaust through a heater for heating the feed water. C. W. KOINER.

This would depend upon the conditions of the plant in question, whether or not there was spare exhaust steam for heating the feed water, and upon the kind of condenser.

I. E. MOULTROP.

Into the air through a heater.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

That depends on the plant. If the plant is equipped with economizers, the place for the pump exhaust is in the receiver, but otherwise it should go through the heater to the air.

W. H. MILLS.

G 15. Which is the more efficient method for surface condensers—the parallel flow or counter-current flow?

A counter-current flow of water through the surface condenser is more efficient. C. W. KOINER.

Some manufacturers advocate one system and some the other. Both systems seem to give about the same results.

I. E. MOULTROP.

Counter-current. H. C. HALL.

G 16. What is the most satisfactory means of removing the oil from exhaust steam so that the condensed steam can be used as a boiler feed?

Use a good make of open heater. A. PETERS.

Reliable oil separator. G. WILBUR HUBLEY.

Use a properly-designed oil eliminator and a surface blow-off on the boiler. W. W. TITZELL.

The best method for removing oil from exhaust steam is to use an oil separator in the exhaust line. C. W. KOINER.

I would suggest the enlargement of exhaust pipe and the use of separator having at least twice the cubical contents of low-pressure cylinder and plenty of baffling surface. Keep down rate of flow of steam through separator to about 25,000 feet. Avoid the use of cylinder oil compounded in excess of from six to seven per cent animal matter, or about 1.5 per cent of paraffin, and which will not decompose or froth at 400 degrees Fahrenheit. C. F. HEWITT.

Any good form of oil separator will do.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

We have found the use of the Cochrane oil separator very satisfactory in removing the oil from exhaust steam, and have used the condensed steam as a boiler-feed without any trouble from the oil. E. F. MCCABE.

We do not think there is any satisfactory method unless it be filtering it through a filter placed in the boiler-feed line.
AUGUSTA RY. AND ELEC. CO.

We use a 14-inch Cochrane oil separator. We return all our steam and find no oil in boilers. R. N. KIMBALL.

G 17. Which are the more reliable under all conditions, single direct-acting or duplex condenser pumps?

If you mean for circulating condenser water there is no difference, but if you mean the air pump, single direct-acting will give least trouble. GEO. W. RICHARDSON.

Single direct-acting. G. WILBUR HUBLEY.

Duplex pumps are the most reliable under all conditions. C. W. KOINER.

Duplex. H. BOTTOMLEY.

Duplex pumps. H. C. HALL.

Single direct-acting pumps. I. E. MOULTROP.

G 18. Which are preferable on condensers for turbine units—steam or electrically-driven circulating and air pumps?

Electrically-driven circulating and air pumps are more economical than steam pumps, but some engineers prefer steam. S. C. FOSTER.

Except in a few special cases it is preferable to have these pumps steam-driven and use the exhaust to heat feed water. P. JUNKERSFELD.

On the continent of Europe electrically-driven circulating water and air pumps, for both engine and turbine units, are extensively used, while English practice is rapidly adopting this system, and I do not doubt that in American practice electric motors will soon be adopted for this purpose. FRANZ KOESTER.

Both are in use, and each system has its advocates. H. BOTTOMLEY.

In a turbine installation steam-driven auxiliaries should be installed up to the point where all the exhaust can be condensed in heating feed water to give the most economical results. I. E. MOULTROP.

See answer to question C 16. J. T. Cowling.

G 19. For maximum economy in a cooling tower, what are the relations between the velocity, humidity and inlet temperature of the air and the circulation of the cooling water?

G 20. Under what conditions would it be advisable to use a cooling tower condensing outfit for small or moderate-sized electric-light plants (a) with reciprocating steam engines? (b) with turbines?

When the commercial savings effected by its use are greater than the cost of operating same plus interest and depreciation on the investment. H. Bottomley.

(a) Where the load factor is high, the average humidity low and fuel and water are expensive it would very probably pay to install a cooling tower of at least sufficient capacity for the long-hour load. Where the boiler-feed water carries a large percentage of scale-forming materials there would be an additional reason for using a cooling tower with surface condenser outfit, as it would provide pure water for the boilers. (b) In the case of turbines, the efficiency is rather low running non-condensing, and even a comparatively low vacuum would greatly increase it. H. T. Hartman.

Only under conditions of limited supply of fresh injection water. G. Wilbur Hubley.

G 21. What is the best way to prevent the accumulation of shellfish in the suction of the condenser?

Use "Ideal" strainer. United Elec. Lt. Co.

Blow steam through it occasionally by direct connection of a small live-steam pipe. Cook 'em. W. W. Titzell.

One method is to use two straining screens in series, so that one may be kept in operation while the other is being cleaned out.
The Edison Elec. Ill'g Co. of Brockton.

Put a good double strainer over end of suction pipe, then when one strainer is being cleaned, the other prevents the entrance of foreign matter. H. C. HALL.

G 22. To what one or more causes in operation or to what short-comings in design or construction do you attribute the failure to secure guaranteed or expected vacuum in the everyday operation of surface condenser plants, either with turbines or with steam engines?

Condenser not large enough, or negligence, or careless packing. As general rule condensers are so simple that they are neglected. G. W. RICHARDSON.

In most cases air leaks at joints in piping or stuffing-box packings. G. WILBUR HUBLEY.

Leaks. W. W. TITZELL.

Leaking joints; bad design of condenser; long pipe lines.
(UNSIGNED.)

The failure of a condensing plant to give the expected vacuum may be caused by, first—designing the condensing plant too small for the work; that is either making the entire installation too small, or having one of the pieces of apparatus under capacity. Second—air leaks in that portion of the condenser and its appurtenances where the pressure is below that of the atmosphere. Third—by the temperature of the cooling water running higher than anticipated, as by warming up during the summer months. Fourth—leakage through the pump used to remove the water of condensation and through the pump removing the vapor of condensation, if there be such a pump in use. The above covers most of the causes for failures in condensing apparatus, but there may be other causes brought about by the peculiar conditions of an individual installation, which would contribute to the failure to realize the desired vacuum, and this would have to be investigated at the special installation.
I. E. MOULTROP.

G 23. Which is the best location for the steam header and auxiliary piping—engine-room, boiler-room or separate chamber?

Putting header in the engine-room insures better inspection and maintenance. In the boiler-room there is less likelihood of damage to engine in case of accident.

AUGUSTA RY. AND ELEC. CO.

In boiler-room, unless plant is of very large capacity. The space required for separate chamber is disproportionately large, and about the only advantage claimed is that it isolates trouble. It is questionable whether or not it really has any advantage in this respect, as a hallway full of steam is not an inviting place to send men for the purpose of clearing trouble.

The engine-room should be as clear as possible of high-pressure piping. There are too many things to look after at the same time and too much apparatus that would be injured by escaping steam to justify placing the steam mains in engine-room if it is possible to avoid it. H. T. HARTMAN.

Put the piping in the boiler-room if it can be conveniently done and the station is not large enough to afford a proper separate chamber. DUGALD C. JACKSON.

Separate chamber, out of drafts, where a uniform and high temperature can be maintained. W. P. HANCOCK.

The separate chamber is the best location for the steam pipe, for the reason that it can be kept clean, free from drafts, and in case of a disastrous steam break it tends to separate the trouble from the rest of the plant. I. E. MOULTROP.

G 24. What are the advantages of a surface-condensing system over other methods of condensing the exhaust steam from turbines?

Pure boiler-feed water and higher vacuum. Otherwise the advantages in the way of first cost of installation, smaller number of moving pieces of apparatus, fewer joints under vacuum, and simplicity of operation, are all with the jet or barometric condenser. H. T. HARTMAN.

The ability to return the condensed steam from the turbine to the boilers, saving not only the water but some heat.

W. P Hancock.

Naturally, in any location some heat is saved by the use of surface condensers where the condensation is returned to the boilers. With the plant located where salt water is used as a cooling medium surface condensers are necessary where the condensed steam is to be saved. I. E. Moultrop.

G 25. (a) What is relative power consumed by surface condensers and the barometric type, in their auxiliaries, for the same vacuum? (b) What is the chance of losing vacuum on throwing off or on full load at once with barometric type of condenser? (c) What is the power consumed by auxiliaries (condensing) for high vacuum?

H

ENGINES

H 1. Is there any known formula for finding the horsepower of a gas engine when the B. t. u. per cubic foot of gas is known?

No; indicate it or apply brake. W. W. Titzell.

This will depend upon the explosion pressure, which runs all the way from 175 to 400 pounds. A. E. Walden.

$$\frac{\text{Cubic feet gas per hour} \times \text{B. t. u. per cubic foot}}{60\left(\frac{33{,}000}{778}\right)} \times \text{thermal efficiency of engine} = \text{horse-power.}$$

C. K. N., N. Y. Ed. Co.

Gas-engine builders generally guarantee a brake-horse-power on 10,000 to 12,000 B. t. u. R. N. Kimball.

If the composition of a gas is known, the air consumption necessary for explosion must necessarily be known. From this fact the B. t. u. available per explosion at full load is determined readily from the size of the cylinder. Now, if the composition of the gas that was used when the engine was tested is known, the performance of the engine with the gas at hand will be found to be very nearly in proportion to the ratio of the B. t. u. in the two equal portions of mixture at full load.

Example: It is proposed to use a gas of 134.15 B. t. u. of the following composition in a gas engine; what horse-power will it develop? The gas engine when tested on natural gas of 1000 B. t. u. requiring 10.5 cubic feet air for explosion developed 100 horse-power.

The composition of the gas to be used was as follows:

Gas	Per Cent	Available B. t. u.	Cubic Feet of Air Required per Explosion
CO_2	8.5	0	0
C_2H_4	0	0	0
O_2	.5	0	0
CO	22.9	74.65	.546
CH_4	3.36	30.57	3.20
H_2	10.41	28.93	.249
N_2	54.33	. 0	0
Total,	100.00	134.15	3.995
Total volume of mixture		4.995	

In one cubic foot of natural gas mixture there are 89.5 B t. u.

In one cubic foot of mixture to be used there are 27 B. t. u.

Hence the horse-power that can be developed would be found by the formula

$$\frac{100}{x} \text{ as } \frac{89.5}{27.} = 33.14 \text{ horse-power.}$$

Formula required is therefore as follows:

$$\frac{\text{Horse-power known}}{\text{Horse-power unknown}} \text{ as } \frac{\text{B. t. u. in cubic feet mixture used in making test.}}{\text{B. t. u. in cubic feet mixture to be used.}}$$

PHILIP F. BALLINGER.

H 2. What is the average gas consumption per horse-power of the average gas engine at one-quarter, one-half, three-quarters, and full load? In each case please state the B. t. u. of the gas per cubic foot, and the pressure under which it was metered.

A prominent manufacturer's guarantee is as follows:

Gas engines will not utilize over 10 to 15 per cent of heat.

12,000 B. t. u. when engine is operated at full load
14,000 " " " " " " " " three-quarter load
16,000 " " " " " " " " half load

As the operating conditions of almost every plant constitute not over 50 per cent power factor, the economy ought to be based on this fact. Geo. W. Richardson.

Each brake-hp requires 12,500 B. t. u.

600 B. t. u. Gas 100 per cent load, 20 cubic feet
75 " " " 23 to 25 cubic feet
50 " " " 27 " 30 " "
25 " " " 30 " 38 " "

A. E. Walden.

The average gas consumption per hp-hour at quarter, half, and three-quarters load depends somewhat on the design of the engine. If of the throttling type with a hit-and-miss attachment when working with natural gas containing not less than 1000 B. t. u. the gas consumption will not exceed

Full load 10,500 B. t. u. per brake horse-power
Half " 12,000 " " " " " "
Quarter " 13,000 " " " " " "

H. M. Beugler.

The average gas consumption per horse-power-hour at quarter, half, three-quarters, and full load on a few of the engines I have tested was as follows:

Gas consumption at per cent of full load		25	50	75	100
Size of Engine	B. t. u. in Gas				
2-hp	560	60.4	46.2	38	31
8-hp	560	46	30.6	31.2	25.5
16-hp	560	44.1	35	29	23.1
165-hp	597	41.2	34.3	24	18.3
165-hp	129.44	148.10	110	97.2	93
165-hp	123.85	155.4	141.5	115.7	97.2
165-hp	128.15	150.3	131	105.3	94.8

This shows that the gas consumption per horse-power in the very small engines was very much in excess of that which was to be found with the larger engines.

Philip F. Ballinger.

See plotted curves in handbook distributed by the Westtinghouse Electric and Manufacturing Company.

R. N. KIMBALL.

H 3. What are the actual running efficiencies and performances of gas engines with producer gas, and the actual costs of plant, fuel repairs and depreciation, as compared with the average steam-engine or turbine plant?

I have found from actual tests made on gas engines of various types that the efficiencies of engines running on half, three-quarters, and full load are as follows:

Per Cent Full Load	Mech. Efficiency	Thermal Efficiency
50	65	12.7
75	70	20.5
100	78	23.7

These efficiencies were found while making runs at constant brake loads for periods of two hours. The engines showed an average heat value given up to jacket water and lost through exhaust as follows:

Per Cent of Load	Per Cent Heat Given Up to Jacket	Per Cent Heat Given to Exhaust and Radiation
50	21.75	58.68
75	29.1	44.7
100	38.7	28.3

The repairs on the gas-engine plant during the year 1904 amounted to $.00219 per kilowatt-hour generated.

The repairs on steam plant during year 1904 amounted to $.004451 per kilowatt-hour generated.

The cost of fuel for gas-engine plant per kilowatt-hour was 0.679 of the cost of fuel per kilowatt-hour with steam.

PHILIP F. BALLINGER.

The actual running efficiencies, considering the load for which the station operates, are approximately the same between producer-gas engines and compound-condensing steam engines and not quite so good as with a turbine plant using superheated steam; the depreciation on the gas plant is larger than with either of the steam plants. Operated under full-load conditions, the gas-producer plant is superior to either of the steam plants. The cost of a producer plant is larger per horse-power than that of either steam-engine or steam-turbine plant. W. L. K.

This question is very ably discussed in the *Electrical Age* for April, 1905. W. R. COLLIER.

Most gas engines are overrated for use on producer gas. In a recent test of a Walrath engine, 60-hp rated, with Wile automatic producer, engine would not develop more than 25 horse-power with constant speed. The coal consumption was 800 pounds of pea coal, at $4.25 per ten-hour run.

R. N. KIMBALL.

H 4. Is a gas engine and suction or pressure gas producer plant of 100 horse-power desirable as an auxiliary to a water-power where one of the prime considerations is quick and easy starting with small extra labor, in order that the regular force need not be increased?

A 100-hp suction producer plant could hardly be called a quick starter, inasmuch as it is necessary to blast up the fire before the gas is sufficiently rich to operate the engine.

W. L. K.

A combined suction and pressure gas producer is seemingly giving the best results. A. E. WALDEN.

Speed variations due to quality of gas varying, are annoying to voltage. Have guarantees on engines and producers drawn so that no money is paid until satisfactory results are assured.

R. N. KIMBALL.

H 5. What has been the development in connection with the use of internal-combustion engines to carry light day loads in plants of 5000 lights capacity and under, where steam is used for peak load? The case we have in mind would involve a 50-kw unit.

We have a three-cylinder gas engine belted to a 60-kw generator, pulling our day load and late-at-night load and giving excellent satisfaction. Voltage regulation is as good as with a steam engine. F. D. ELWELL.

The Diesel engine is peculiarly fitted for this work, as it will enable a steam plant to dispense entirely with the fire-room labor and a day engineer. NORMAN McCARTY.

H 6. In view of the guarantee made by manufacturers of gas engines and producers of one brake-hp-hour per pound of coke or anthracite coal, why are not such outfits more generally installed?

Because owners are afraid of the gas engine. This fear being based upon troubles that have been overcome in the modern gas engines. CHAS. N. SHAW.

The probable reason is that the efficiency of the gas engine drops off quite rapidly from full load and also at the present writing the gas engine, operated from producers, is still in an experimental stage. The depreciation and maintenance are also appreciably larger than on steam installation. W. L. K.

Producers and gas engines should be bought from the same company, so that there will be no shifting of loads and responsibilities in case of failure to get guaranteed results.

R. N. KIMBALL.

It is our opinion that the answer to this question is, that they can not make their guarantee good under actual operating conditions. An explosive engine operating at 50 per cent load factor using gas fuel, requires about 16,000 B. t. u. per brake-horse-power, and as coal will not average over 12,500 B. t. u. 80 per cent efficiency in gas producer would not give over 10,000 B. t. u. per pound of coal for us in the engine; consequently they would require 1.6 pounds of coal per brake-horse-power under the average operating conditions of the plant, without considering stand-by losses, when the engines are out of service.

NORMAN McCARTY.

H 7. (a) What is being done with regard to running gas engines direct-connected or direct-belted to another shaft which

is already driven by steam engines? (b) Will the gas engine operate satisfactorily connected with steam-driven machinery?

Just as good results as can be had with steam engines of different makes, as the regulation is equal to or better than most steam engines, the speed only changing from day to day as the quality of gas changes; but if the speed is adjusted when starting and other units brought to this speed when starting no trouble will be had on this score. A. E. WALDEN.

This has been tried in many ways, such as adding largely to the weight of the gas-engine flywheels and using double and triple-cylinder engines. Very little success, so far as I have seen, has ever been obtained in this direction, however.

G. H., N. Y. ED. CO.

There will be no difficulty in connecting a Diesel engine either by belt or direct to the line shaft, operating from a steam engine. The regulation secured in the Diesel engine is fully equal to that of steam, which is probably the information your questioner desired. NORMAN McCARTY.

H 8. (a) Which have you found to be the cheapest power—steam engines, steam turbines, gas engines running on producer gas or Diesel engines? (b) Why are not the Diesel engines more used?

(b) These engines have not been more used on account of unreliability of operation.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Due to the very high thermal efficiency of the Diesel engine, as well as to the crude quality of the oil that can be used to operate it, the actual cost of the fuel per hp-hour when operating with this style of engine, will be much less than any other form of power generation; but the cost of the Diesel engine (both first cost and cost of maintenance), the difficulty of getting started, the unreliability of its operation and its lack of the high-grade speed regulation of the steam engine, have prevented its general adoption.

In my opinion, the high-grade Corliss steam engine and the high-grade steam turbine are in a class by themselves, and are far superior to any other form of power generation (water-power excepted) that has ever been devised. Between the steam engine and the steam turbine, the actual economy of the former, up to the present time, is slightly greater than that of the latter, while the first cost and cost of maintenance of the latter, together with its economy of space, strongly recommend it over the former. It would seem that the steam turbine, as it is perfected, will gradually supplant the steam engine. GEORGE HOWE.

The probable reasons why Diesel engines are not in more general use are:

(1) High initial cost.

(2) Greater complication than engines of the more familiar types.

(3) Trouble experienced on account of the unreliability of gas engines in general has probably prejudiced many engineers against internal-combustion engines of any type.

H. T. HARTMAN.

The Diesel oil engine is costly to install and is not as yet tested by time. R. N. KIMBALL

The writer has had no experience with a Diesel engine, but has understood that the question of the mixing has given considerable trouble. The steam turbine, for all-round conditions for power-house use, running on variable or fluctuating loads with capacity for overload, has proven to be the cheapest, including in this term cost of operation, maintenance, depreciation and repairs. With good compound condensing engines where the units are so divided as to be able to run some of them at full-load rating, the turbine economy is approached. On gas engines operated with producer gas, the trouble in regulation, cost of maintenance, depreciation, interest on investment, and failure to take any great over-load, more than counterbalance their straight economy on fuel operation. W. L. K.

H 9. (a) Are there any electric-light stations in the East using oil engines of the Diesel type, and if so, how does the cost per kilowatt for fuel compare with that of steam engines with coal at the prices prevalent in New England, or, say, $4.00 to $4.25 per ton? (b) Will the repairs and charges for depreciation offset the saving? (c) Is this service to be relied on?

At Jewett City, Connecticut. A. E. Walden.

There are three electric-lighting stations using Diesel engines in the East, for the sale of commercial light and power. One at Jewett City, Conn., which has been in operation two years, one at Mansfield, Mass., which has been in operation one year, and another at Provincetown, Mass., which has been in operation seven months. Norman McCarty.

I do not know of any station in the East at present operating in this manner. However, I will say that the Tyrolean Alps exhibit at the World's Fair, St. Louis, was operated by a large plant of this character with fairly good results. The ratio between the Diesel motor and the high-grade Corliss engine, so far as actual fuel cost is concerned, would seem to be in favor of the Diesel engine. Nevertheless, the cost of repairs, depreciation, poor regulation, and unreliability, fully offset the advantages of the Diesel engine. G. H., N. Y. Ed. Co.

H 10. What are the ratios of fuel consumption per indicated horse-power of the American Diesel engine and a first-class single-cylinder Corliss engine of standard type running non-condensing, steam at 110 pounds and cutting off at one-fourth stroke?

To make a proper comparison would require that oil be burned under the steam boiler or else that a comparison be made for each different kind of coal that may be used.

An approximate comparison of the relative efficiencies of steam and internal-combustion engines may be obtained from the table on page 119 of the *Preliminary Report on the Operations of the World's Fair Coal-Testing Plant of the United States Geological Survey,* which describes fourteen tests made on different kinds of coal, portions of each of these samples being used in a steam plant and portions of each in a gas plant, and showing an average efficiency in the steam plant of 4.27 pounds of dry coal per electrical horse-power, and in the gas plant 1.7 pounds of dry coal per electrical horse-power. (UNSIGNED.)

H 11. Is there any good reason why a modern, well-built vertical cross-compound engine of 1000 horse-power should not be run at 1000 feet piston speed per minute?

We do not observe the slightest difficulty in operating 1200-hp horizontal cross-compound Corliss engines at a piston speed of 800 feet per minute. W. P. HAZELTINE.

No; it is common practice on steamships to run at 1000 feet piston speed. G. H. CUSHMAN.

There should be no difficulty in operating well-designed engines at 1000 feet piston speed. It would be better, however, to limit the piston speed to 900 feet per minute.
I. E. MOULTROP.

H 12. What is the difference in economy at half load and upward between compound non-condensing engines, 125 pounds pressure, and a simple engine working at same pressure? Engines, say, of 100 or 200 horse-power.

About three per cent. GEO. W. RICHARDSON.

Compound engines are about 10 to 15 per cent more economical than single-expansion engines if the engine is condensing, but not much more so without condensers, and on fluctuating loads the economy is questionable. S. C. FOSTER.

Simple engine is more economical under conditions noted.
G. WILBUR HUBLEY.

The comparative efficiencies depend largely on the make of the engines. If designed to carry overload, it is doubtful if at 50 per cent load the compound engine would show a smaller

steam consumption than the simple, while at full load the compound should show about 10 per cent greater efficiency.
W. H. WHITTON.

All technical works give us about 15 per cent gain in favor of compound non-condensing engines over simple engines, and this is borne out in practice. W. H. MILLS.

H 13. How does the economy of medium-speed 4-valve engines, other than those of the Corliss type, compare with that of high-speed compound engines?

High-speed compound engine. G. WILBUR HUBLEY.

Tests have shown in many instances that the medium-speed, four-valve engines use about 10 or 15 per cent less steam than high-speed. W. H. WHITTON.

Medium-speed, four-valve engines show better economy than high-speed compound at low pressures. One hundred and twenty-five pounds is about as low a pressure as should be used with compound engines and this is higher than should be used with four-valve engines to get the best results. H. T. HARTMAN.

H 14. What is the greatest number of r.p.m. at which a standard make of Corliss engine of the automatic releasing valve gear type may be safely and economically operated?

I have run a Corliss engine 128 revolutions per minute. The size was 14-inch by 30-inch and the make was a Sioux City Corliss. I experienced no trouble with the releasing gear, but would advise knowing if the flywheel will stand this increase before attempting to speed it up. GEO. W. RICHARDSON.

Engines of the releasing-gear type are limited to a speed of 90 r.p.m. or less, since if the speed is increased beyond this limit the valves will not work properly. S. C. FOSTER.

Consider 100 revolutions per minute as maximum economical limit, although they are made for higher speed.
G. WILBUR HUBLEY.

I have run them at 150 r.p.m., and had no trouble from the high speed. G. B. LELAND.

Our chief engineer at one time installed a Sioux Corliss engine 11 by 24 at 150 revolutions per minute, with no bad results, and it was very economical.
THE COLORADO SPRINGS ELEC. CO.

One hundred to 120 revolutions per minute.
AUGUSTA RY. AND ELEC. CO.

H 15. What advantages in overload capacity can be obtained by equipping Corliss engines with separate eccentrics for steam and exhaust valves?

Fifty per cent increase in overload capacity.
G. WILBUR HUBLEY.

A single eccentric Corliss engine will not cut off above one-third; with double eccentrics it will be increased to three-fourths with a corresponding decrease of back pressure at release under heavy loads, and the compression can be handled to a greater nicety. A. E. WALDEN.

The range of cut-off can be increased from 45 to 75 per cent and still have expansion. G. H. CUSHMAN.

Longer cut-off can be obtained by the use of separate eccentrics. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Corliss engines equipped with separate eccentrics for steam and exhaust valves will have a range of cut-off from zero to three-quarters stroke, while Corliss engines with one eccentric controlling both steam and exhaust valves have a range of cut-off from zero to seven-sixteenths stroke. If load is such that valve does not trip between zero and seven-sixteenths stroke, it will not trip at all, but will take steam about eleven-twelfths of the stroke. H. C. HALL.

With the ordinary Corliss valve gear, the admission of steam is limited to one-half the stroke, while with the long-reach type, with separate eccentrics for steam and exhaust valves, admission of steam for three-quarters of the stroke can be obtained. E. F. McCabe.

H 16. (a) Have you had experience with 4-valve (Corliss or other) engines with two eccentrics and a shaft governor? (b) Are they not likely to replace, for general electric power plant purposes, the regular style of Corliss engine?

(b) For direct-connected units this seems to be the general trend. W. B. Roland.

(b) Yes, I believe so. G. Wilbur Hubley.

(a) We have known three builders of steam engines to attach Corliss valves to a shaft (isochronal) governor and in every instance they failed and were abondoned. A Corliss valve must have a fixed travel always. William Wright, who designed the Corliss valve, always used slide gridiron valves for the cut-off and his so-called Corliss valves for the exhaust. The trouble was that they could not be kept tight, on account of uneven wear. (b) No. W. W. Titzell.

H 17. Which is the more economical—medium-speed belted Corliss or high-speed direct-connected automatic?

If the belt is of the proper size and is not connected up to a long jack shaft, and the engine is run at or near its maximum load, the Corliss steam consumption will be less than that of the high-speed automatic. Geo. W. Richardson.

Medium-speed belted Corliss. G. Wilbur Hubley.

Medium-speed Corliss, belted. W. W. Titzell.

Medium-speed belted Corliss are more economical than high-speed direct automatic engines. C. W. Koiner.

In a station where room is not an important item a medium-speed Corliss engine will be found the more economical.
E. F. McCabe.

H 18. Is there more or less leakage through valves and pistons with superheated steam than with dry saturated steam, pressure being the same?

More, as it is nearly a fixed gas. W. W. Titzell.

There should be slightly less leakage with superheated steam, because the vacuum is somewhat greater than that of saturated.
I. E. Moultrop.

H 19. What has been found to give best results in practice with regard to leakage, friction and wear in piston valve engines —plain piston valves or adjustable?

Adjustable valves. G. Wilbur Hubley.

Adjustable piston valves of proper design are superior to solid piston valves, as the solid valves soon wear and leak steam.
C. W. Koiner.

H 20. In an ordinary compound-condensing engine, which is the more economical (and why)—a low receiver pressure (as 6 pounds), or medium pressure (as 8 or 10 pounds)?

This point should be determined by indicator.
G. Wilbur Hubley.

It depends upon the load on the engine; the receiver pressure should be maintained as near as possible to the terminal pressure in high-pressure cylinder. G. H. Cushman.

The most economical drop is dependent to a very great extent on the ratio of cylinder volume. An approximate balance of the work done between the two cylinders is desirable, though not absolutely essential, and of course the division of the work fixes the drop. A medium amount of drop is not wasteful, as the unresisted expansion into the receiver dries the steam and may in some cases superheat it. C. F. Haywood.

The most economical receiver pressure is the pressure that allows the governor to revolve in the highest plane, which, of course, produces an earlier cut-off in the high-pressure cylinder, no matter whether receiver pressure is 6 or 10 pounds, as the low-pressure cylinder can not use any more steam than is supplied by the high-pressure cylinder. H. C. Hall.

On a steady load the receiver pressure should be such that each cylinder should do its share of work, but on a variable and light load the low receiver pressure is most economical.

W. H. Mills.

H 21. Does the term "clearance" in an engine cylinder apply only to the space between piston and head when on the dead centre or does it include the passageways from valve to cylinder?

Generally speaking, the term "clearance" means the distance the piston is from the head, but when the percentage of clearance is spoken of it is the ratio to the volume of the cylinder of the volume of the space between the piston and head plus the passageways to the seat of valve. Geo. W. Richardson.

The clearance is the volume of the space between the piston and cylinder head when the engine is on dead centre plus the volume of the steam port leading to it. The clearance of an engine may be found by putting the engine on dead centre and pouring in water until the space between the piston and cylinder head and the steam port leading into it is filled; the volume of the water poured in is the clearance. S. C. Foster.

Clearance includes all space between the piston and the cylinder head, when the piston is at the extreme point of travel, and the space of passage for admission of steam between admission valve and cylinder Wm. Wiatte.

Chas. N. Shaw.

G. Wilbur Hubley.

W. W. Titzell.

The Edison Elec. Ill'g Co. of West Chester, Pa.

C. W. Koiner.

C. F. Hewitt.

C. F. Haywood.

O. H. Young.

The Colorado Springs Elec. Co.

Sam'l Kahn.

H. S. Russell.

J. F. Dostal.

W. P. Hancock.

I. E. Moultrop.

The Edison Elec. Ill'g Co. of Brockton.

C. W. R., N. Y. Ed. Co.

Augusta Ry. and Elec. Co.

W. H. Mills.

C. C. Gartland.

The term "clearance" denotes the space between the piston and head in addition to the cubical contents of the ports or passageways at that end of the cylinder. Clearance is generally expressed in terms of a percentage of the piston displacement.

D. L. Carver.

In its technical use the term "clearance" of an engine refers to the proportion of the space in the cylinder *and the associated passages* that may be occupied by steam but over which the piston does not sweep; that is, it includes the passageways from valves to cylinder.

Dugald C. Jackson.

The term "clearance" is used in reference to distance between piston and head when crank is on centre. This term is also used to designate the volumetric measurement of all passageways and spaces included between piston-cylinder head and valves, and is used in this sense when referring to economy of steam consumption. J. S. ROBINSON.

When the space between cylinder head and piston is taken with engine on dead centre, this is termed "working clearance." But when we include ports from valve to cylinder head, then we term it "cubical clearance." H. C. HALL.

As generally accepted, the term "clearance" applies to space between the piston at the end of the stroke and the cylinder head. Writers on the steam engine, however, generally include the passageways from valve to cylinder. E. F. MCCABE.

H 22. What is the usual per cent of clearance in (a) a high-speed automatic engine; (b) in the Corliss?

The clearance may be as low as 0.5 per cent in Corliss engines and as high as 14 per cent in very high-speed engines.
GEO. W. RICHARDSON.

Automatic cut-off high-speed engines of the best design, with shaft governors, usually compress to about half the boiler pressure and have a clearance of from seven to 14 per cent. Corliss engines have but very little compression, owing to the construction of the valves; they likewise have very little clearance; it may be as low as 0.5 per cent. S. C. FOSTER.

Two per cent. G. WILBUR HUBLEY.

Clearance in high-speed engines varies from seven to 14 per cent. Corliss engines will run as low in some cases as four per cent or less.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Clearance in high-speed engines amounts to as much as 13 per cent and in a Corliss engine it runs as low as 0.6 of one per cent. C. W. KOINER.

H 23. Are phosphor-bronze piston packing rings better than cast-iron when using superheated steam, say from 500 to 750 degrees Fahrenheit?

Parkins used composition on 500 pounds of steam, Steamer *Anthracite*. W. W. TITZELL.

H 24. What can be done to prevent the governor of a centre-crank engine, direct-connected to a multipolar generator, from vibrating or shivering when running with or without a load? In the case referred to everything has been done to see that the engine is in perfect line and in good working condition, by the builders. Steam distribution has been changed in every way possible and a second governor wheel with a different pattern governor has been tried.

If there is a dash-pot on the governor see that the holes in the piston of same are clear, and if the fluctuation of load is very great use a thin oil; if not, use a thicker oil in pot, and be sure the pot is full. If there is no dash-pot on the governor the trouble may be in the valve chest. If your voltmeter is not steady I am quite sure you will find by indicating your engine that one end of the cylinder is doing most if not all of the work. I have found this to be the case several times. Maybe the lubrication of the valve is not good, or the packing in the stem is binding. When a valve is set by the eye to tram marks, it does not assure you that the valve is set correctly because when the valve is working under steam pressure and temperature to correspond with this higher pressure, expansion throws the valve off; therefore, a valve of a steam engine should only be pronounced correctly set after quite a number of indicator cards are taken from the engine. GEO. W. RICHARDSON.

This is inherent trouble in design in centre-crank engine.
G. WILBUR HUBLEY.

We have found two faults, the correction of which steadied the governors on our engines decidedly. Ours are inertia governors. On one, a Russell engine, the slide-valve binding between the valve seat and the lugs inside the steam-chest cover caused the trouble. There were no springs behind these lugs, as on a Mansfield, and as a gasket under steam-chest cover was compressed more and more as the engineers "took up" on the nuts to prevent leaking, it was finally compressed so thin that there was not room between the face of the lugs and the valve seat to allow the valve to work freely. We put in a copper gasket, which could not be compressed too much, and have had no further trouble.

With an inertia governor the governor weights and the eccentric are keyed to a pin which is free to oscillate or revolve in a bearing in a spoke of the flywheel.. On the end of this pin, on side of spoke opposite to weights, is a cap, to prevent its working out. There should be no binding of this cap against the spoke when screwed up tight, or pin will not work freely in its bearing and governor will shiver and regulation be bad. It was necessary for us to put shimming under the cap on one of our engines, and as it took us some months to discover that this was where the trouble with our governor was located, our experience may help some one else. W. H. THOMSON, JR.

We should suggest putting a dash-pot on the governor, or, if one is already on, substituting a heavier one for it.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

H 25. In operating a non-condensing compound engine under light loads, does it conduce to economy to run with low boiler pressure during the light-load period?

If the load is exceptionally light and engine large, indicate the engine. If the expansion curve extends below the atmosphere line and causes a negative loop, it would be advisable to lower the steam pressure, because the negative loop is wasted power; besides, the vacuum produced in the cylinder by this negative loop will cause the exhaust valves to rise from their seat, and in time will ruin them. By lowering the steam pressure this loop can be avoided. GEO. W. RICHARDSON.

Yes. G. WILBUR HUBLEY.

It would be better to lower the pressure for light load and not let the steam drop below the atmospheric line.

C. W. KOINER.

Most certainly. An 18-inch by 36-inch horizontal engine with full load at 100 revolutions developed 235 horse-power with 95 pounds boiler pressure. With 15-hp load and 20 pounds steam this engine ran quietly and "sweet," but with 95 pounds of steam this same engine would race so badly that it could not be trusted. Boiler pressure should be best suited to the load, which can be easily found with the indicator. W. W. TITZELL.

When the light loads reduce the cut-off to so small a percentage of the stroke that cylinder condensation of serious moment occurs, it pays to reduce the boiler pressure so as to avoid this excessive cylinder condensation, which may be the cause of great losses in fuel. The point at which it may become economical to reduce boiler pressure depends upon many things, including the type of the engine. DUGALD C. JACKSON.

Yes. G. H. CUSHMAN.

Yes. W. P. HANCOCK.

The mean effective pressure will vary as the load. The question therefore is, will the low mean effective pressure be more economically produced by correspondingly low boiler pressure, or by maintaining the boiler pressure and reducing the mean effective pressure by an early cut-off? As by the former method the engine would be operating at more nearly its full-load condition and therefore higher on the efficiency curve, it is probable that if the light-load period were of sufficient duration a lower boiler pressure would be economical. W. H. WHITTON.

H 26. What per cent of loss should be figured between the indicated horse-power of a Corliss engine at 100 r.p.m. and a belted generator at 475 r.p.m. at 50 per cent load and full load?

This depends upon the friction load. As a rule it is safe to figure that 100 kilowatts at the switchboard will equal 150 horse-power at the engine if the friction load of jack shafts is not excessive.

GEO. W. RICHARDSON.

About 25 per cent at half load and 10 per cent at full load.

G. WILBUR HUBLEY.

The ratio of actual to indicated horse-power in the case of a moderately large sized unit would be from 75 to 80 per cent. The efficiency of the generator should be from 85 per cent at half load to 92 or 93 per cent at full load. This makes the total loss about 44 per cent at half load and 26 per cent at full load.

C. F. HAYWOOD.

Three efficiencies being involved at each load—that is, of the engine, of the dynamo, and of the belt transmission—the condition of the apparatus would determine largely the loss. Why not indicate the engine and read the terminal current and voltage and thus get the information direct?

W. H. W., N. Y. ED. CO.

H 27. Is not the small belted unit for stations up to 400-hp with short load peak and 30 to 100-kw all-night load, more economical than larger, 200 to 400-kw units, direct-connected, where fuel is only $1.00 per ton? Does it not make a more flexible station to operate, with less liability to disablement?

Yes; either small belted or direct-connected units would make a more flexible station to operate.

GEO. W. RICHARDSON.

Yes, under conditions of load as specified.

G. WILBUR HUBLEY.

The actual operating expenses of any plant are but a small percentage of the total gross costs, and in your case are exceptionally low. If your present equipment is economically designed and maintained as regards leaks in steam mains, etc., it will certainly not pay you to install the large units.

C. F. HAYWOOD.

This makes a more flexible station to operate and might in some cases make a more economical one, but would increase rather than lessen the liability of disablement.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Why not have, say, one 200, one 100 and one 50-kilowatt unit, direct-connected? This would be both economical and flexible, the objectionable feature being the necessity of keeping on hand three sets of duplicate parts. W. H. W., N. Y. ED. CO.

H 28. Why do stations continue to use the most uneconomical engines for 20 hours of the day and the best of power for the four hours remaining?

This is usually the result of providing for the future needs of a city, rather than the present. There are few plants whose loads do not increase steadily, with prospects of their day load growing, and it is to meet these conditions that uneconomical engines are sometimes installed when plant is built. As good practice, however, it can hardly be recommended; it is far better to make ample provision in building, and add boilers and engines as required. CHAS. H. PETERS.

Often because of the fashion for large units, resulting in the purchase of units so large that they can be loaded advantageously for only a few hours per day. In extension of small and even moderate-sized power-houses it is usually advisable to select a size and type of unit that will give best results during the 18 or 20-hour period and to use the older and less economical units during the short-hour period only, even though this may mean a little more boiler capacity in peak months, or the buying of two smaller instead of one large unit. P. JUNKERSFELD.

Because the efficiency of a poor engine is better at full load and the greatest economy is obtained by the best engine at light load. FRED B. SHARPE.

It is a lack of good judgment. G. H. CUSHMAN.

This is practically answered by the answer to the foregoing question. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Perhaps because they don't read the *Question Box* and its replies. W. H. WHITTON.

H 29. What changes are necessary in a Corliss engine with double eccentric, to get more compression in the crank end of cylinder when the reach rod from wrist plate to exhaust valve has been adjusted all that it will allow?

Shift exhaust eccentric ahead on shaft, making its action earlier; you can then get the adjustment you desire.
G. H. CUSHMAN.

Turn eccentric ahead and readjust reach-rods.
E. W. FURBUSH.

Reduce clearance in crank end, or give exhaust eccentric more lead and readjust valves by indicator.
J. H. ROBINSON.

Advance eccentric on shaft, shorten rod on head, and exhaust and lengthen rods on both steam valves.
THE PHILADELPHIA ELEC. CO.

I

TURBINES

I 1. How far is it profitable to carry the superheating of steam for use in turbines?

On the continent of Europe it is well known, because of the extensive experience with turbines and superheated steam, that the higher the degree of superheat supplied in the turbine itself, the higher the efficiency. Temperatures of superheat up to 300 degrees and more are commonly used, while in this country and in England 150 degrees of superheat is commonly considered the maximum for favorable operation. This 150 degrees of superheat is supplied at the boiler, so the turbine is supplied with dry saturated steam, not with superheat.

The writer wishes to point out the fact that European experiments have proven that for every nine degrees Fahrenheit of superheat supplied to the turbine, a decrease of one per cent in the steam consumption is obtained. FRANZ KOESTER.

Two hundred degrees Fahrenheit is about the limit of practice to-day. I. E. MOULTROP.

I 2. What steam pressure and what degree of superheat are best suited to steam turbines?

One hundred and seventy-five pounds pressure and 300 degrees superheat. (See also answer to I 1.)

FRANZ KOESTER.

Average conditions are 175 pounds steam pressure and 150 degrees superheat. I. E. MOULTROP.

I 3. In what percentage does the degree of vacuum and of superheating affect the economy of turbines?

The observation and research of the writer regarding 500-kw and 1000-kw two-stage turbines, indicate that for each inch of vacuum above 26 inches about 1.25 per cent to 1.5 per cent is gained in efficiency, and that with superheat of 100 to 125 degrees Fahrenheit on 150 pounds steam pressure, from seven to eight per cent gain in efficiency may be expected.

C. F. HEWITT.

See answer to I 1. FRANZ KOESTER.

Would refer you to March number of *Practical Engineer*.

C. F. HAYWOOD.

The gain in economy due to superheat and vacuum of turbines varies with the design of the turbine and the make, and, apparently, is not subject to any method of calculation.

I. E. MOULTROP.

Above 25 inches, every additional inch of vacuum reduces the consumption of steam by about three per cent. The first 100 degrees of superheat reduce the steam consumption by 7.5 per cent and the first 150 degrees by 10 per cent.

GEORGE HOWE.

I 4. What are the arguments for and against steam turbines as compared with reciprocating engines when same are to be operated non-condensing?

The first cost, attendance, and space occupied, of the turbine *versus* the reciprocating engine, when both are non-condensing, are all in favor of the turbine. I. E. MOULTROP.

The claim is made for a 500-hp Rateau turbine set that when running without load, the dynamo being excited, the steam consumption was 10 per cent of the full-load consumption, whereas a reciprocating engine would take 15 to 25 per cent. At full load this turbine uses 21.1 pounds of steam per kw-hour, a very low figure for an engine of this size. In the light of other tests, however, it is doubtful if the turbine is actually more economical of steam to any marked degree than the reciprocating engine.

W. H. WHITTON.

The steam turbine is less economical than the reciprocating engine where operating non-condensing. Therefore, where economy is a prime consideration, its adoption would be inadvisable. Its low first cost, simplicity of construction and operation, compactness, and high speed, will no doubt cause it to continue to make deep inroads into the steam engine's field for this class of work. GEORGE HOWE.

I 5. Would it be advisable to use steam turbines where the exhaust steam is used for heating, giving a back pressure of 3 to 10 pounds?

The company with which the writer is connected operates a combined railway, lighting and steam-heating plant, and has found the steam turbine to be altogether unsuited for operation against any back pressure whatsoever, from an economical standpoint. C. F. HEWITT.

I 6. With a load factor of about 40 per cent, with a jet condenser giving an average of 26 inches vacuum, would a 400-kw steam-turbine set operate as cheaply, fixed expenses included, as a compound Corliss non-condensing engine?

There is a growing impression that at the present time steam turbines in sizes less than 1000-kw can not compete successfully with reciprocating engines. (UNSIGNED.)

Steam-turbine set should operate under these conditions from six to ten per cent below the engine costs.
THE PHILADELPHIA ELEC. CO.

Depends on cost of fuel and other conditions. Generally, if fuel is high, yes; if very low and other conditions peculiar, the engine might be preferable. P. JUNKERSFELD.

I 7. Is the steam turbine advisable for small stations? State minimum size of units.

No. Minimum size, 1500-kilowatt.
G. WILBUR HUBLEY.

If steam consumption alone were considered, it is a question if turbines of any size would receive the preference over reciprocating engines, as they have yet to demonstrate any marked superiority in that respect. In the matter of space, simplicity, attendance, supplies, and perhaps repairs, the turbine appears to have the advantage. It would hardly seem advisable to install turbine units of less than 200 horse-power and larger sizes only if superheated steam and condensers are to be used. W. H. WHITTON.

I 8. Are turbines of small capacity as efficient under variable loads, such as exist in a small railway power-house, as small steam engines of the same capacity?

I 9. Will some of the companies who are operating steam turbines give the pounds of coal (giving B. t. u. per pound) necessary to produce a kilowatt-hour at the switchboard?

Refer to report of the writer to committee on Steam Turbines. C. F. HEWITT.

I 10. Does a steam turbine require more or less pounds of steam per kilowatt-hour output at switchboard than same size unit Corliss compound-condensing engine, both running at 175 pounds steam pressure, 150 degrees Fahrenheit superheat, and 27-inch vacuum?

Under the given conditions a steam turbine would show a lower steam consumption than would a Corliss compound engine. The guarantees for the 7500-hp Allis-Chalmers Corliss engines for the Interborough Rapid Transit and Manhattan power plants in New York are, respectively, 12.25 and 13.0 pounds per indicated hp-hour, while that for the 5500-kw Westinghouse-Parsons turbine for the London underground road at full load is 13.2 pounds per effective hp-hour; or, assuming an efficiency of 85 per cent, 11.2 pounds per indicated hp-hour. For the 5000-kw Brown-Boveri-Parsons turbine for the Paris underground road, the guarantee is 9.5 pounds per indicated hp-hour. The vacuum and pressure in the two latter are the same, while the superheat in the latter is approximately double that used in the former.

FRANZ KOESTER.

The steam turbine in average sizes should be about as economical in pounds of water per kilowatt-hour as the reciprocating engine. In the large sizes it ought to be a little better.

I. E. MOULTROP.

I 11. What is the momentary and sustained overload capacity of the steam turbine compared with that of the Corliss engine?

We have found that our turbine will stand 50 per cent momentary and sustained overload. We could not get this with our Corliss engines. UNITED ELEC. LT. CO.

The efficiency of turbines is not supposed to vary so greatly either side of the rated load as does that of engines.

(UNSIGNED.)

Momentary and sustained overload capacity of steam turbines in our experience much greater than those of Corliss engine. Regulation under both conditions far superior to engine results. THE PHILADELPHIA ELEC. CO.

I 12. Is not the inertia governor better adapted for steam turbines than the purely centrifugal governor?

I 13. How long will steel buckets in steam turbines withstand the effects of wet steam, pressure 140 pounds, before they wear sufficiently to decrease the steam economy by 10 per cent?

There does not appear to be any appreciable wear on the buckets of the turbine. I. E. MOULTROP.

I 14. (a) What is the wear on turbine vanes, and how does this change their clearance, and (b) what type of turbine is least affected by change in clearance?

Both types of turbines require attention as to the adjustment of the clearances. When these are properly made they should give no trouble. I. E. MOULTROP.

I 15. What difficulties have developed in the practical operation of steam turbines?

Up to date the troubles and defects encountered in the use of steam turbines appear to be remarkably small and of no great moment. I. E. MOULTROP.

I think the importance of steam-turbine trouble is overestimated, though it is freely admitted by the manufacturers that they have had trouble. Every fully-developed machine represents the gradual elimination of defects arising in its predecessors. It is therefore unfair to condemn a machine on account of real or fancied difficulties that have arisen and been eliminated. Some writers condemn the turbine on account of blades stripping and bearings cutting, mechanical unbalancing, and so on, but I do not know what turbines they refer to. If they had closely investigated the reports from plants operating a well-known type of turbine in Europe and plants having turbines of similar type in this country I do not think they would feel justified in their contentions. All the trouble that has arisen from the above was in no manner due to faulty turbine design, but to distortion of casings by expanding exhaust pipes and in no case have the bearings of a turbine of this type been known to heat or cut. This turbine is designed with sufficient bearing area to support the weight of the rotating parts without the use of oil under pressure, and the oil is circulated by the turbine itself, so that it is impossible for the oil supply to shut off while the turbine is running. Engines also have their trouble from this cause, cylinders and valves cut, governors get out of order even to the extent of fly-wheels bursting and finally wrecking the engine. All well-ordered plants have hose available for submerging hot engine hearings. Mechanical unbalancing in the turbine creates disturbances to the extent of not requiring massive foundations and holding-down bolts, as in the engine.

The wearing of the blades from erosion of steam is frequently advanced as an argument against the turbine. To be sure everything depends on the design, but experience shows that in general the wear does not represent an excessive rate of depreciation on the turbine as a mechanism. The only points where the turbine has not met the engine are extremely low speeds and belted units. Both are characteristic of passing engineering practice rather than present. We will all agree that the steam consumption of the turbine is a disappointment.

S. C. FOSTER.

J

DISTRICT HEATING

J 1. Does steam reduced from 100 pounds to 1 pound through a reducing valve contain more heat than steam from exhaust at one pound, or than steam generated at one pound; if not, what becomes of the energy that is apparently lost?

It will contain more heat if a reducing valve is used.

GEO. W. RICHARDSON.

There is very little apparent energy lost with the 100-pound pressure on boilers over that required at one pound pressure. The heat units contained in a pound of steam of one pound pressure being about 1148, while at 100 pounds pressure a pound of steam contains 1185. Comparing the steam of one pound pressure reduced from 100 pounds through a reducing valve to exhaust in engine, we can find but little difference, as the engine is simply acting as a reducing valve.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Yes; it has effect of superheating.

G. WILBUR HUBLEY.

One pound (by weight) of steam reduced from 100 pounds (gauge pressure) to one pound (gauge pressure) contains more heat than steam from exhaust at one pound (gauge pressure) or than steam generated at one pound (gauge pressure). The energy apparently lost is not lost by reducing the pressure (assuming no work done), but superheats the steam at the lower pressure.

Saturated exhaust steam, or generated steam at 16 pounds absolute pressure (1.3 gauge pressure) contains a total of 1147.9 B. t. u. (above 32 degrees Fahrenheit) per pound weight of steam. Saturated steam at 115 pounds absolute pressure (100.3 gauge pressure) contains a total of 1185 B. t. u. (above 32 degrees Fahrenheit) per pound weight of steam. The difference (1185 — 1147.9 = 37.1 B. t. u.) goes into superheating the low-pressure steam.

F. N. JEWETT.

Steam under these conditions usually does contain more heat units than exhaust steam. Part of the surplus heat, however, is frequently used in vaporizing the moisture of the steam where it was moist; part is also radiated from the reducing valve and pipe connected thereto.

GEORGE HOWE.

Steam reduced from 100 pounds to one pound through a reducing valve contains more heat than if generated at one pound in boiler, or steam from exhaust at one pound, because it is superheated.

H. C. HALL.

There is no reducing valve manufactured that contains enough surface to radiate the very considerable amount of heat that is set free in reducing steam from a pressure of 100 pounds on one side of the valve to one pound on the other side. As only a small portion of this heat can be radiated, it necessarily follows that the steam at one pound pressure carries more heat than, so to speak, it is entitled to carry by its pressure, or, in other words, it is superheated. That this statement is based upon actual fact has been demonstrated in practice, where a considerable economy in operation has resulted in live-steam plants, when the boiler pressure has been increased to pressures approximating 80 to 100 pounds, passing steam through a reducing valve and reducing its pressure to from 5 to 15 pounds in the mains; whereas former practice was to have the boiler pressure and the line pressure the same.

AMERICAN DISTRICT STEAM CO.

J 2. Does district heating justify the expenditure in towns where heat does not have to be distributed further than 1000 feet from the central station, where the heating amounts to between 50,000 and 100,000 square feet?

It depends on local conditions of load, cost of fuel, type of generating apparatus, kind of system, and price obtained for heat service. Generallly speaking, it would pay.

F. N. JEWETT.

The returns from district heating would certainly justify the cost of installation under the conditions named, provided there is sufficient waste exhaust steam to supply the heat required. H. T. HARTMAN.

I should say yes, especially if you have exhaust steam for part of the time. The distance you mention is very short and there ought to be but small loss in the underground line.

N. WALLACE.

This question can only be answered by parties interested estimating that they can obtain from $3.00 to $4.00 per thousand cubic feet of space heated during the season when heat is required. If the revenue received will not justify the investment, it will not be a success. C. R. MAUNSELL.

Short distances are necessary to profitable operation. The question of average load and whether the plant runs condensing or not are deciding factors. R. N. KIMBALL.

Emphatically yes. The probabilities are that the income derived from the sale of heat with a meter rate of 50 cents per 1000 pounds would amount to between 25 and 30 cents per square foot of radiation per season, provided the climatic conditions of the town in question were similar to those in towns in Ohio, Indiana, Illinois, *et cætera.* The total income to be derived from the sale of heat with this amount of radiation connected would, therefore, lie between $15,000, on a basis of 50,000 square feet connected, and $30,000 on a basis of 100,000 square feet connected. It is unusual to find so large an amount of radiation located so closely adjacent to the station as in the illustration given in this question. H. C. Eddy.

J 3. Does district heating pay if you go beyond the amount of exhaust steam furnished by your engines; if so, at what price? (Give price and heat value of coal.)

No. G. Wilbur Hubley.

Depends on local conditions; investment; type of apparatus; whether or not extra labor is required; kind of system used. Generally speaking, however, the following prices—which are approximate—should be obtained where live steam must be used to supplement available exhaust. Coal is assumed as having 12,000 B. t. u. per pound, and at $2.00 per ton equals

For hot-water heat, 20 cents per square foot per year.
For steam heat, 35 cents per square foot per year.

F. N. Jewett.

Where the local conditions are proper, district steam heating can be made a profitable business by itself, as witnessed by the financial success of a considerable number of live steam heating companies. The price that can be secured for heating service—sufficient to pay profit—depends upon too many different factors, which vary in different localities, to make it possible to make any accurate statement that will be generally applicable, further than to say that the operating cost, including all factors, should not exceed 50 per cent of the gross receipts.

American District Steam Co.

I know of but one cause if the system is well put in, and that is leakage of air in some part of the system or through the piston of the pump. N. WALLACE.

Theoretically, yes; practically, after five years' experience, no. Coal $2.60 13,000 B. t. u. We increased our business 40 per cent and found poorer results, we decreased it again and made more money and gave more satisfactory service. R. N. KIMBALL.

J 4. Will it be a proper thing to put a centrifugal pump on the return main of a hot-water main that has a back pressure of 10 pounds, one mile away from the station? There is a sag of 6 feet in our main at that point; the mains are of same size, supply and return. Most of this distance is down grade.

No. F. N. JEWETT.

J 5. In operating district steam-heating plant on Paul vacuum system, we find it impossible to maintain vacuum; what is the most probable reason for same?

To operate a steam-heating plant successfully on the Paul system a great deal depends on the setting of the air inlet-valves on each radiator for the proper opening; too much or too little will be detrimental to good results; also there may be small but numerous leaks in piping, stuffing boxes, *et cætera*. The composition plugs on radiators may need renewing; all these being in good order, there ought to be no trouble in getting from 12 to 15 pounds vacuum with a very small opening of the ejector.

H. C. HALL.

The most probable reason is that there is a leak somewhere in the air line or that some of the air valves on the radiators are out of order and do not properly perform their function. The remedy would be to make a thorough examination and test of the air-line fittings and also to determine whether or not sufficient pumping capacity is installed to properly remove the air from the system. AMERICAN DISTRICT STEAM CO.

There are so many places where air leaks are possible that a vacuum is hardly to be expected. H. T. HARTMAN.

The most probable cause of loss of vacuum, in our experience, is the tampering with air valves by the occupants of the buildings.
C. R. MAUNSELL.

J 6. Under what conditions does district heating from a central station pay?

A large amount of business to be reached with short mains, high-priced domestic coal, and the exhaust steam to furnish the supply.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Only under conditions of limited area and excess of minimum amount of exhaust steam available throughout the season requiring heat. G. WILBUR HUBLEY.

As long as you have sufficient exhaust to keep pressure in mains. (UNSIGNED.)

A good round price for service, and this depends on local conditions. No rate can be made to fit all conditions, any more than can a rule be made for the profit in electric lighting. What would be a fair price in one city would be low in another and prohibitive in still another. F. N. JEWETT.

Where the net balance remaining after deducting operating expenses from gross receipts returns a profit on the investment necessary to secure the business that is satisfactory to the investor. This is rather a broad statement but is about the only one that can be made generally applicable. To approximately determine in advance whether a district steam-heating system can be made to pay a satisfactory return on the investment, requires a careful study of the conditions present in the particular locality under consideration. These local conditions, including average temperature, length of season, cost of steam and domestic fuel, character of population, character of business served, whether business buildings or residences, whether live or exhaust steam must be used, and if both, in what relative quantity, amount of street mains necessary to reach the business, all vary within such wide limits that it is hardly possible to generalize. AMERICAN DISTRICT STEAM CO.

J 7. (a) Has any one tried using a double expansion joint on the steam mains, instead of the variators? If so, with what success? (b) Have they been able to insulate the mains from the frost as well with this as where bricked over in the manner in which the variators are covered?

We have had both variators and double and single-expansion joints on our heating system for the past three years, and have had no trouble with either. Our slip joints are in manholes. Joints are first covered over with asbestos paper, then filled in with from six to eight inches of sawdust or mineral wool.

THE COLORADO SPRINGS ELEC. CO.

Yes. Double-expansion joints are frequently used instead of variators. They are best adapted for use in lines where service connections are not frequently made, as a double-expansion joint will take care of the expansion of very much more pipe than will a variator. They can not, however, be bricked over as variators can, but must be enclosed in a manhole so that access may be had to them for packing. The cost of maintenance, barring accidents, is higher than for variators.

AMERICAN DISTRICT STEAM CO.

I do not quite understand what you mean by variators—it is a term not used here; but as for expansion joints, either double or single, I should not use them if it could be avoided. I like what we call a swing expansion or offset. If properly put in and of good length, using two L's and a short nipple at each end of the offset, they give no trouble; but don't attempt to economize by using a single L at each end.

N. WALLACE.

J 8. Will it be good investment to install heating system in a town of 5000, laying 2000 feet of pipe, no day load but station running 16 hours per day, with peak from 150 to 200

kilowatts, slack at 50 cents in bin, domestic coal at $2.50? Town already has a number of steam-heating plants in business houses.

Yes, if proper price is charged for service. More detailed data would be required to enable one to say just what that price should be. F. N. JEWETT.

Generally speaking, it would not be a good investment to install a central-station heating system in a town of 5000 inhabitants, with no day load. If your plant is centrally located and you could furnish all your customers with exhaust steam, it would possibly pay; otherwise we think not.

E. F. McCABE.

On the face of it, the conditions seem favorable; local conditions would have to determine definitely.

AMERICAN DISTRICT STEAM CO.

A heating system would be practically certain to show a loss under the conditions named. H. T. HARTMAN.

J 9. Is there a meter for steam heating that gives reasonably accurate results and reliable service?

No; measure the water of condensation.

GEO. W. RICHARDSON.

The condensation meter used for steam-heating installations will give very fair results, but the reliability is not all that can be desired.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

The writer has obtained good and interesting results with the simplex condensation meter made by the American District Steam Company, through careful and frequent inspection.

C. F. HEWITT.

Yes; American District latest type meter.

(UNSIGNED.)

We are using the American District Steam Company's simplex condensation meter, in connection with cooling coils, with very good results. THE COLORADO SPRINGS ELEC. CO.

The condensation meter has been improved in mechanical detail and during the past heating season has given general satisfaction to those using it.

AMERICAN DISTRICT STEAM CO.

J 10. What is the economical limit of distance for the transmission of heat by steam or hot water in district heating? What "head" in pounds per square inch is required per 1000 feet of line for the transmission of heat by steam at the pressure employed?

In Colorado Springs the City Hall is about 3500 feet from our heating plant. At 20 degrees below zero we carried seven pounds back pressure at plant and delivered steam at four pounds at City Hall, which gave them all the heat necessary. Street main trapped at three points.

THE COLORADO SPRINGS ELEC. CO.

The economical limit of distance for the transmission of heat by steam depends altogether on the distribution and amount of heating business. The limit of distance from a mechanical standpoint has not been found. There are several companies successfully transmitting steam a distance of approximately two miles radius from the station as a centre. The loss in pressure, due to condensation, friction of pipes, *et cætera,* is much less than is ordinarily supposed to be the case, and depends more upon the demand, due to buildings connected, than any other cause. In one instance, a steam line approximately 6000 feet long without re-enforcement delivers steam at the extreme end in average winter weather at a loss in pressure of from one-quarter to one-half pound; in extreme weather with a loss from one and one-half to two pounds. By "extreme weather" is meant temperatures ranging considerably below zero point.

AMERICAN DISTRICT STEAM CO.

If pipes are of proper size the loss in pressure is very little. In our plant we have one line supplying heat to seven buildings, college dormitories, lecture-rooms, library, military armory, *et cætera.* Steam main is 2000 feet long, back pressure gauge and heating-system gauge indicate two and a half pounds pressure and gauge at far end of line one to one and a quarter pounds.

N. WALLACE.

J 11. To what extent is it economical to supply exhaust steam for heating?

Enough to keep the back pressure of the engine below four or five pounds. There is a plant at Peoria, Ill., using exhaust steam for district heating where they tap the receiver of a cross-compound Corliss engine direct to the street mains. They have an adjustable screw and vernier to adjust the cut-off of the low-pressure cylinder while the engine is in operation, and I am informed that it meets the requirements of an ideal district-heating system, from the standpoint of both economy and flexibility. GEO. W. RICHARDSON.

To the full extent of the exhaust, if business is within reach of short mains. Interest, depreciation and repairs on investment of service pipes and mains being the chief expense connected with the business.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

To the extent only of the amount of excess of available waste exhaust steam under the minimum conditions of the heating season. G. WILBUR HUBLEY.

If the town is small, or thickly populated in proportion to its size, and there are a large number of steam-heating users in the immediate vicinity of the central station, the selling of exhaust steam for heating purposes might prove profitable. However, if the heat units in the exhaust steam are to be supplied for heating purposes, I believe that the hot-water system is by far the best, as the engines may still continue to be operated as condensing engines, giving up the latent heat in the exhaust steam to the condenser water, and this water be circulated through insulated pipes to steam-heating users at such a moderate temperature that radiation from these pipes will be very small. Such a system, I understand, has been most successfully operated at Evanston, Illinois. George Howe.

The real meaning of this question is not altogether clear. Taking it for granted that the questioner desires to know to what extent it is advisable to carry back pressure on his engine, would say, this would be determined very largely by the style of engines used. So long as operating conditions do not make the cost of furnishing exhaust steam exceed the cost of furnishing the same amount of live steam, everything being considered, it is advisable to use exhaust steam in preference to live steam. American District Steam Co.

J 12. (a) Is it not time to place "district heating" in its proper place as a business by itself? (b) Can it be made to pay its own way? (c) What is the ideal method of making charges for this ideal heat? (d) Provided regulation at plant is good, has any efficiency been gained by use of regulators on houses for hot-water heating, from actual reliable tests?

(a) No. (b) A heating plant alone, operated purely as a heating plant, can not be made to pay except in rare and isolated cases. (c) Meter basis. This is ideal, but more "ideal" than practical. F. N. Jewett.

District heating has suffered more from lack of intelligent management than from anything else, and, until recently, from the absence of any accurate means of measuring the consumption of steam. Where careful and intelligent management has been given district steam-heating plants, uniformly successful results, from a financial standpoint, have been secured. The only proper way of charging for heat from a central station is on the basis of meter measurement. Heat is more easily wasted than any other commodity furnished by a public-service company. A radiator is a condenser and the rate of condensation of steam in a radiator is directly dependent upon the temperature of the air surrounding the radiator. If the temperature of the surrounding air be kept at a low point, by open doors, windows or the like conditions, the rate of condensation is immediately greatly increased over normal and proper conditions. This is done without warning. If gas is allowed to escape from a gas jet, its odor attracts attention at once. If gas is burned unnecessarily, the light and heat produced serves as a reminder to the customer and it is turned off. If electricity is used for illuminating or power purposes, its use is accompanied by certain visible phenomena that act as a sort of alarm, but the rate of condensation of steam in a radiator may be almost instantly increased to several hundred per cent of the normal rate, through a current of cold air from an open door or window, without any warning being given. Moreover, no two consumers use steam in the same quantity, even under similar conditions, and it is manifestly unjust to charge the same rate to different consumers for widely different amounts of consumption.

AMERICAN DISTRICT STEAM CO.

For the past three years the Committee on District Heating has been endeavoring to make a place for this valuable adjunct to light and power business and will be glad to receive, from any one, suggestions that may prove of interest to the members engaged in this branch of business. It certainly can be made to pay its own way.

The ideal method of charging for heating is the meter system, supplemented by supervision of the installation to guard the customer's utilization of all heat units delivered to the building. Thermostatic regulators, if inspected occasionally, give good results, both in the regulation of temperature and the saving of expense for heating.

C. R. MAUNSELL.

The ideal method of charging is a combination of meter and flat rate based on square foot of radiation required for steam plants. There is a large class of business in which the average meter use would not justify the necessary investment in station capacity. A readiness-to-serve charge must be made in addition to meter rates.

Efficiency has been gained in hot-water plant by the use of the thermostat; 40 per cent of the amount of water pumped has been saved.

R. N. KIMBALL.

J 13. Which is the better plan where a new lighting and power company is establishing a station with an expected annual load factor of 30 per cent, 24 hours' lighting service—to operate the heating system with live steam and engines of the highest possible efficiency for generating current, or to use engines of lower efficiency, utilizing exhaust for heating?

The question of operating the combined heating and lighting station was thoroughly experimented on by the writer some six years ago. After a series of exhaustive tests it was found that the general station economy was very much improved by using engines of high efficiency, heating the feed water from the exhaust of the engines, and not attempting to put any back pressure whatever on the engines by forcing the exhaust through steam-heating mains. This test covered high and low-efficiency engines, with engines running condensing to running with as high as 7.5 pounds back pressure. W. L. K.

The peak of the daily heating load comes during the early morning hours. The peak of the daily lighting load comes during the late afternoon or early evening hours. This means either the use of considerable live steam for the heating peak or no demand for considerable exhaust steam at the lighting peak. The heating demand is heavy on considerably less than one-half of the total hours in a seven-month heating season. For all the remaining hours of the entire year, engines of reasonably good steam economy are advisable, even though it be necessary to use some live steam for heating for a short time in the morning on cold days. P. JUNKERSFELD.

It is better to use engines of lower efficiency, utilizing the exhaust for heating. See answer to question J 1. It will be seen that but little of the total heat in the steam can be taken out in useful work, even in a theoretically perfect engine.

F. N. JEWETT.

If the exhaust can be all used for heating, the engines during the heating season will have an efficiency of nearly 100 per cent and the class of engine used cuts very little figure. If enough fuel can be saved during the warm season to warrant the increased investment in high-efficiency engines it will pay to install them, otherwise the low-efficiency engines will be the proper ones to use.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

This is a question of supplying heat by means of steam in large quantities at a low pressure and corresponding temperature rather than in small quantities at a higher pressure and very much higher temperature. The former method is always desirable. GEORGE HOWE.

Depends upon length of heating season and amount of heating. R. N. KIMBALL.

J 14. Why is better circulation secured with exhaust steam at any pressure than with live steam at the same pressure supplied through a reducing valve?

Exhaust steam is not a steady flow and tends to move condensed steam along to openings; also destroys eddies and dead-ends in the system. THE COLORADO SPRINGS ELEC. CO.

There is no reason why exhaust steam should circulate better. F. N. JEWETT.

If the reducing valve is in good condition, the circulation should be every bit as good as with exhaust steam at the same steam pressure. W. H. WHITTON.

J 15. How can a readiness-to-serve charge be incorporated in a meter rate for heating, and what should such a charge cover?

The readiness-to-serve charge should be based on the size of the meter required for the installation under consideration, and should provide for not less than seven monthly bills.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Make the readiness-to-serve charge some price per square foot of radiating surface connected. Make it cover all fixed charges. F. N. JEWETT.

Readiness-to-serve charge should be based on square feet of radiation necessary under the local temperature conditions, based on investment, interest and depreciation charges per square foot. R. N. KIMBALL.

J 16. What are the best material and method for covering steam pipes in streets to obtain maximum efficiency in transmission of heat units to consumers?

Wyckoff patent wood covering. F. N. JEWETT.

Pipes enclosed in a conduit of vitrified sewer pipe that is split lengthwise and is known here as the K. & M. conduit. This should be large enough to give at least three inches all round the steam and return pipe, and the space should be filled with asbestos sponge. This is the best of anything I have found and, in fact, it is good enough. Mineral wool is good if the pipes are wrapped with asbestos paper so that the wool will not come in contact with the pipes and pit or corrode them. Have used cork clippings, but shall not do so any more—not much.

N. WALLACE.

J 17. Has any practical method been devised for measuring quantity of live steam delivered to district-heating mains when exhaust is insufficient?

It has been proposed to use the Venturi tube as a means for determining flow of gases. Its use for this purpose is, of course, not so simple as that of water. There appears, however, to be no serious reason why it may not be made to serve such purposes.

A. BEMENT.

There are two indicating steam meters on the market, one known as the St. John, which is largely used by the New York Steam Company, New York city, and the other, the Sargent. Neither one of these meters is an integrating meter, but both indicate the quantity of steam passing through them at any given time. AMERICAN DISTRICT STEAM CO

J 18. How much more will central-station heating customers pay per annum for central-station heat than the cost of running their own heating apparatus?

This depends altogether upon the individual conditions and the personal characteristics of the customers. In some cases, central-heating station customers are willing to pay as much as 100 per cent advance, in order that they may be relieved of the annoyance and expense of running their own heating plant. In other cases, customers think that a 10 per cent advance in cost to them is excessive. AMERICAN DISTRICT STEAM CO.

Customers certainly do pay more for central-station heating than it would cost them to run their own installations; just how much more they would be willing to pay depends on the customer, and it would be a rather delicate question to ask.

H. T. HARTMAN.

We doubt if anyone can answer this question satisfactorily except in the following manner: Determine what you can evaporate and distribute a thousand pounds of water for, and make this a meter rate after adding as high as 50 per cent on the actual cost of evaporation and distribution, and you will find plenty of customers willing to pay the rate, when charged by meter that records condensation in pounds.

C. R. MAUNSELL.

J 19. How many, if any, steam traps should be placed on a steam-heating main of 4000 feet length, with six right-angled bends in full length?

Ordinarily, if no obstructions are encountered which cause pockets in the line, a trap to each 800 lineal feet of main is sufficient. Practice varies through very wide extremes, depending upon the natural grades and other local conditions encountered. AMERICAN DISTRICT STEAM CO.

On a gravity return system we don't use traps on the returns. We use seals of steam high enough to balance the pressure and a margin over. We never carry more than two and a half pounds on our line and we have seals 10 feet high. This prevents steam ever blowing through, and the return water flows through into the receiver without trouble. N. WALLACE.

J 20. In laying street mains for steam heating with exhaust steam, which will cause the least trouble and have the longest life—variators or brass-lined slip joints?

Variators. AMERICAN DISTRICT STEAM CO.

K

GENERATORS AND EXCITERS

K 1. Would the vibration be objectionable in a direct-current generator direct-connected through a pair of bevel mortise gears to a vertical water-wheel?

Yes; if vibration is excessive, it will cause distortion of fields and consequently sparking of brushes.
G. WILBUR HUBLEY.

By having two bearings on the machine and an outboard bearing on the pinion shaft, the vibration ought to be kept down within good working limit. AUGUSTA RY. AND ELEC. CO.

K 2. What is better than cylinder oil and vaseline for lubricating collector rings?

Nothing, if properly applied. W. H. GREENSLIT.

Hoard's Delight commutator dressing (liquid).
GEO. W. RICHARDSON.

We know of nothing better than pure vaseline, used sparingly. Most commutator compounds, when used on copper-strip brushes, find their way between the leaves, spreading them, and it is not easy to remove these deposits without injuring points of brushes. CHAS. H. PETERS.

Either ordinary engine oil or olive oil is better than cylinder oil. O. H. YOUNG.

I prefer coal-oil with carbon brushes, as it prevents gumming.
J. D. SAUNDERS.

We have used paraffin with perfect satisfaction.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

K 3. (a) Should a small central station install polyphase generators, and (b) how can the difficulty of balancing the circuits be overcome?

Unless there is an isolated case of large power service in which a motor unit of 50 or 100 horse-power is required, there is really no reason why a polyphase generator should be installed in an ordinary sized city, or a small town. It sometimes happens, however, that the city water pumping can be secured by the central station, and that a motor in excess of 50 horse-power will be necessary. In such event, a polyphase generator should be installed; but otherwise the writer's recommendations would invariably be for a single-phase machine. There is practically no kind of service existing in a small city, other than a rare instance of large power, which can not be thoroughly taken care of with a single-phase motor. It would, therefore, be "borrowing trouble" to install a polyphase generator and attempt to use it as such. If a polyphase machine has been, for special reasons, installed, we very strongly recommend either operating it as a single-phase machine or putting in a switchboard which permits of using a polyphase set of 'bus-bars with single-phase feeders running out therefrom.

Polyphase generators are capable of being operated at 75 to 80 per cent of their rated capacity on single phase, and it would be advisable from every point of view in the ordinary plant to run as a single-phase machine rather than as a polyphase. If a polyphase switchboard arrangement is installed, the use of the proper throw-over switches will enable all distribution, or practically all, to be single-phase. These single-phase feeders can be thrown from one phase to another of the 'bus-bars and the load kept fairly balanced on the different phase windings of the generator. With such an arrangement, each feeder should be controlled with an independent pressure regulator, and when such an arrangement is provided, the maintenance of a balanced voltage on the polyphase 'bus-bars is entirely unnecessary, as each feeder can be furnished its required voltage within a range of, say, 10 per cent, without adjustment of the 'bus-bar voltage.

WAGNER ELECTRIC CO.

If the load is within reasonable distance of the plant (say within 8000 feet) it would hardly be necessary to use three-phase generators. If the load is greatly unbalanced it might be a good plan to split the feeders, taking some load off the heavier feeders and throwing it on the lighter.

C. F. HAYWOOD.

No; except that if polyphase generators are installed a number of small single-phase circuits should have proper switches to throw them on any phase of generator.

W. S. GREENSLIT.

If polyphase generators must be used, I would suggest two-phase rather than three-phase for ease of balancing. Have double-throw switches on each circuit; you can then throw on one or other set 'bus-bars and keep system balanced.

A. PETERS.

No. F. C. S., MALDEN ELEC. CO.

Use three-phase, if you have a power load, and run all the lighting circuits from one-phase, regulating the voltage for this phase only. G. B. LELAND.

Yes, if power is to be supplied. The difficulty of balancing circuits on three-wire, three-phase system can be partially overcome by installing feeder regulator on each feeder. A little care and judgment in connecting circuits to the different phases will do the rest. I have operated such a system for several years and have had no serious difficulty in maintaining a reasonable balance with very little trouble. W. F. OVIATT.

Generally speaking, no station under 500 kilowatts can get good regulation at station with polyphase generators unless the number of circuits is large and their connected load small.

The difficulty is less troublesome, however, using two-phase generators with independent windings than with three-phase generators of an equal capacity. W. H. C.

Yes, with a view of prospective motor business. Divide circuits so that by means of switches different phases can be loaded equally. HARRY HOLLIS.

Desirable to install single-phase apparatus entirely.
G. WILBUR HUBLEY.

Would consider single-phase machines preferable for any small plant. A. R. MACKINNON.

Have found the following arrangement to work satisfactorily: Install two-phase generator with single-phase distribution circuits and series alternating arc-lighting system. Operate arcs on one phase and incandescent circuits on the other. Regulate generator voltage for incandescent service and let constant-current transformers take care of street system at whatever voltage they get. F. D. ELWELL.

Not advisable unless some motor business could be secured; in that case balancing could be secured by using a plug and cable board. C. W. HIGGINS.

In a small central station having a three-phase motor load it would probably be policy to install polyphase generators and use feeder-potential regulators on lighting feeders to maintain the proper voltage. Absolute load balance is not so necessary. In case of a lighting load only, single-phase machines are preferable. E. J. BECHTEL.

It is not advisable for small stations to install polyphase generators, for the reason that few, if any, small stations carry a sufficient number of circuits to strike a decent balance between them. If lighting is of first importance, we recommend single-phase, 60 cycles. If a small amount of power is desired in the daytime, and station is centrally located, you would be ahead in the long run by installing a 250-volt, direct-current generator to take care of this power service. CHAS. H. PETERS.

Polyphase generators are of no ultimate advantage unless power is to be furnished. If the station is small, and the power a small part of business and in small units, the single-phase system has many advantages, and the unbalancing feature will be eliminated. Polyphase generators admit of parallel running, which is an advantage, but not necessarily in a "small" station. If polyphase system is adopted the circuits may be balanced by cutting over the load, or by means of automatic feeder regulators.

GEO. B. LAUDER.

Unless a station is very small, polyphase generators are preferable to single-phase; also, unless very small, the distribution can be divided into two parts for a two-phase system. If a little excess capacity is allowed in the generator, exact balance between the phases is not necessary. THE SEATTLE ELEC. CO.

A small station with two-phase machine has always two chances instead of one in case of lightning or short-circuit.

AUGUSTA RY. AND ELEC. CO.

No matter how small a central station may be, it is good policy to install polyphase generators, so that a power load may be taken care of as well as the ordinary lighting load. It is not necessary to balance the circuits on polyphase generator. The lighting circuit may be run off one phase and the voltage of the generator adjusted on one phase only. Then use the three phases for power work. F. G. PROUTT.

Where there is a possibility of obtaining a motor load it is advisable to install polyphase generators. We are operating two two-phase generators and distributing single-phase from the switchboard. With some changes on our circuits we have found no difficulty whatever in balancing the phases.

E. F. McCABE.

No. C. M. WRIGHT.

A small station should not install a polyphase machine unless large motors are a possibility. Circuits can be balanced by having proper switchboard arrangements to throw any circuit on any phase. R. N. KIMBALL.

Not unless motors larger than five per cent of capacity of generator are to be supplied. As both phases parallel each other, it is easy to transfer lights, or single-phase motor load from one phase to the other to keep them balanced.

J. T. COWLING.

K 4. What advantages or disadvantages has an induction-type generator over a revolving-field type on inductive and non-inductive load?

No particular difference in electrical characteristics. Would prefer the revolving-field type for mechanical reasons.

W. H. C.

On inductive load an induction type generator may be unable to maintain sufficient voltage. THE SEATTLE ELEC. CO.

By induction in this question, it is assumed that inductor is meant. If both types of machines are built for the same inherent regulation, then there should be no particular advantage of one over the other.

In the inductor generator the armature magnetism does not reverse, and the armature coil is subject to about one-half the variation in magnetism that is usual with the rotating-field type. Therefore, for equal weights of active material the inductor machine should have twice as many armature conductors as the rotating-field type; or if the number of armature conductors is made the same, the induction must be practically doubled in the inductor type with consequent great increase in amount of material. In order to keep the weight of the inductor type down to a reasonable figure it has been the practice of some makers to adopt the middle course in design. Machines built on such lines would have relatively more armature conductors than the rotating-field type and would have somewhat poorer inherent regulation on both non-inductive and inductive loads. Also, to lessen the weight the inductor machines are frequently worked much nearer to saturation than on the rotating-field type, and therefore in many cases have not the margin for holding up voltage on severe inductive loads.

THE WESTINGHOUSE ELEC. AND MFG. CO.

K 5. Under what conditions, if any, have you found automatic circuit-opening devices advisable on generators or exciters?

Operating at overload. W. H. GREENSLIT.

They furnish protection to the generator, and are proper apparatus to have. GEO. W. RICHARDSON.

Short-circuits, lightning, overload, are taken care of better by using circuit-breakers than by depending on fuses, and the circuit-breakers will act quicker. ANDREW F. HALL.

No conditions. F. C. S., MALDEN ELEC. CO.

Automatic circuit-opening devices on generator or exciters are an advantage as protection against overload, such as short-circuits. They should be adjusted for only such emergency troubles. G. WILBUR HUBLEY.

For direct-current apparatus get a reliable circuit-breaker of an overload and reverse-current type. Set overload trip 300 per cent over machine capacity and reverse current from three to 12 per cent. HARRY HOLLIS.

We are installing automatic oil switches on all generators that operate in parallel. Tripping coils of these switches are energized through time-limit relays from the exciter 'bus and have their circuits provided with small knife switches by means of which they are disconnected after generators are paralleled. With this arrangement, if an incoming generator is thrown in out of step and does not rapidly pull into synchronism with the generators already running, it is automatically thrown out. We do not think it is advisable to use automatic circuit-opening devices on exciters. HARRY M. HOPE.

Do not think they are advisable on either generators or exciters, and should never be used on exciters. C. W. HIGGINS.

The Denver Gas and Electric Company has abandoned the use of all circuit-opening devices. A short time ago a heavy short occurred on the switchboard, but was burned off without throwing the generators out of synchronism, the voltage dropping (of its own accord) till the short was burned away, when the machines came up again together without any trouble.

C. F. HAYWOOD.

Only when set to operate at from 75 to 100 per cent overload. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

We are using circuit-opening devices on feeders instead of generators, as our generators will be stalled in case of heavy short-circuit on generator. AUGUSTA RY. AND ELEC. CO.

K 6. What are the comparative advantages and disadvantages of self and separate excitation for large direct-current generators?

When one generator is to be thrown in with another by using separate excitation, you are sure of incoming generator building up the right way. A. PETERS.

The separate excitation seems useless except to save the five per cent of exciting current taken from the generator, or in building up. GEO. W. RICHARDSON.

One advantage of separate excitation for large direct-current units is that with certain systems of automatic regulation a much more uniform voltage will result. GEO. B. LAUDER.

Self-excited machines are more compact, though they vary more in voltage than those independently excited from a constant source of electromotive force. AUGUSTA RY. AND ELEC. CO.

K 7. Is an induction motor-driven exciter set ever advisable for alternating-current generators?

All right, if installed with storage battery. A. PETERS.

The writer thinks that an induction motor is a necessary adjunct to a modern station. F. C. S., MALDEN ELEC. CO.

In large stations where from convenience or the standpoint of appearance of machinery it is not desirable to drive direct from engine, exciters driven direct-connected to simple high-speed engine are probably more economical if exhaust steam can be used for heating boiler feed. W. H. C.

Yes; where alternative is also provided.
G. WILBUR HUBLEY.

An induction motor may be used for driving the exciter if provisions are made for picking up the load after a severe short-circuit. Having a direct-connected engine-exciter set the engine may be belted to an induction motor with the engine governor set at a slightly lower speed than the engine will then be running. A little steam should be allowed to run through the cylinder for lubricating. Should the motor slow down, the steam will then pick up the load. THE COLORADO SPRINGS ELEC. CO.

Might be used as an auxiliary set, but there should be one or more sets steam or wheel-driven in case of complete shut-down.
C. W. HIGGINS.

Inasmuch as the cost of operating a motor-driven exciter is practically one-half the cost of operating an engine-driven exciter, and the cost of maintenance on the motor-driven set is less than on an engine-driven set, it would seem advisable in nearly all cases to use induction motor-driven sets for alternating-current generators. Practically the only exception would be in cases where lines outside the station are subject to very frequent and heavy short-circuits, which would be liable to cause a shut-down of the exciter, and even these cases can in a large measure be overcome by having no automatic circuit-opening device between generator and induction motor. J. S. WHITAKER.

The Denever Gas and Electric Company has been using a set of this kind with success. C. F. Haywood.

It certainly is. Geo. B. Lauder.

Yes. A steadier voltage will be had with a motor-driven exciter than with the exciter belted direct to the generator.
J. F. Dostal.

If a station has a motor-driven excitation equipment with no storage battery as an auxiliary, induction motor-generators for excitation would have some advantage over a synchronous motor-generator, as in case of severe disturbances to the system the induction motor would be less likely to drop out of step and shut down the station.
The Edison Elec. Ill'g Co. of Boston.

Judging from the number of such installations, one is led to believe that it is. H. Bottomley.

Yes; for alternating 200-kw and over.
The Edison Elec. Ill'g Co. of Brockton.

An induction motor-driven exciter is very advisable for exciting alternating-current generators. Should it be used, however, either an engine-driven exciter set or a small exciter battery should also be installed, as it would be impossible to start up the induction motor without first having current on an alternating-current generator. F. G. Proutt.

An induction motor-driven exciter set is very convenient, and advisable as a reserve. Augusta Ry. and Elec. Co.

K 8. In large power stations where steam and electric-driven exciters are now both provided, which is it more economical to use after starting up?

Electrically-driven. F. C. S., Malden Elec. Co.

Steam-driven either from main or independent engine if proper use is made of exhaust steam of engine. W. H. C.

The steam consumption for a 5000-kw unit is 14 pounds of steam per electrical-hp-hour.

The steam consumption for a 75-kw unit is about 30 pounds of steam per electrical-hp-hour.

The efficiency of a motor-generator set is 85 per cent. The steam consumption per electrical-hp-hour delivered by the motor-generator set is then $14 \div .85 = 16.4$ pounds electrical-hp-hour, showing a decided advantage in favor of the motor-driven exciter. If the exhaust steam from the small steam unit be used for heating purposes, the advantage will be somewhat less, depending on maintenance and repair of small steam set, but, usually, still in favor of the motor-driven exciter.

W. S. MUNRO.

Electrically-driven exciters are the more economical.

G. WILBUR HUBLEY.

Electrically-driven. C. W. HIGGINS.

Under average conditions it is far more economical to use motor-driven exciters after a plant has been started up. With the average steam exciter set not exceeding 100 kilowatts capacity it is not usual to obtain better economy than 40 pounds of steam per kilowatt-hour, whereas with the large engines of a station it is not uncommon to obtain economy of 16 pounds of steam per kilowatt-hour. Hence, allowing 80 per cent efficiency for the motor, you would obtain economy of 20 pounds of steam per kilowatt-hour for power delivered to the exciter generator, or practically one-half the amount of steam required to drive a steam exciter set. J. S. WHITAKER.

Electric. J. F. DOSTAL.

Motor-driven exciters are by far the most economical units to use for continuous operation.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Electric-driven.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Where steam and electric-driven exciters are both provided, the electric-driven generator would be much more convenient for general operation; whether it would be the more efficient or not would depend entirely on its size and also on the average load that it would have to carry. If the steam-driven exciter were comparatively small, the engine would take a larger amount of steam for its operation, probably two or three times as much as that required by the steam engine-driven generators that were being excited from the exciters. So, although the electric-driven exciter might have a total efficiency of only 50 per cent, it might, on account of the high efficiency of the unit from which it was taking current, be more efficient than the engine-driven exciter set. It would certainly be much more convenient.

F. G. PROUTT.

It depends on the amount of exhaust steam needed for heating feed water. If feed water is hot enough, motor-driven exciter is most economical. J. T. COWLING.

K 9. Is it not a good policy to install an exciter of double the capacity required and use an armature of double the voltage and operate at half speed?

I think the money necessary to install such a machine could be spent to better advantage. A. PETERS.

I fail to see any advantage, as the first cost would be greater, and such a machine would be compelled to run at its maximum load at its lowest efficiency. GEO. W. RICHARDSON.

The writer thinks it good policy to install an exciter of double the capacity if there is chance for the plant to grow rapidly. Do not see any advantage in having armature of double voltage operating at half-speed.

F. C. S., MALDEN ELEC. CO.

No. G. B. LELAND.

Probably no gain. Commutation may be better, but at full load in amperes heating of armature will be greater, due to decreased ventilation at half-speed. W. H. C.

No. G. WILBUR HUBLEY.

There seems to be no advantage in installing an exciter of double capacity with double-voltage armature, operated at half-speed, except to increase the first cost of the machine something like 30 or 40 per cent, as the constants of such a machine would be very nearly the same as those of a machine of proper capacity. Manufacturers of electrical machinery can be trusted to furnish a machine quite as satisfactory in operation as that which any central-station man is likely to evolve. J. S. WHITAKER.

No. The fixed costs would more than unbalance any good this arrangement might do. C. F. HAYWOOD.

No. A properly built machine purchased from a reliable maker should be able to operate satisfactorily at rated speed and voltage. THE SEATTLE ELEC. CO.

It shows very poor confidence in the exciter if it is judged necessary to make it twice as large as actual capacity requires. AUGUSTA RY. AND ELEC. CO.

As the ratings of modern, first-class electrical apparatus are based on continuous performance, there is no reason why putting in an exciter of double the capacity and running half voltage would be any more satisfactory than putting in an exciter and running at normal rating. A very much better policy would be to put in an extra exciter set, and in all well-conducted stations more than one exciter set is used anyway. The amount of insurance you would get from arranging your exciter, as stated in the question, would not be enough to justify the extra expense of such a machine. F. G. PROUTT.

K 10. In connection with an underground Edison 3-wire system operated from a substation, which of the three methods of conversion from 60-cycle alternating current to direct current,

namely, rotary converters, induction motor-generator sets, or synchronous motor-generator sets, will give best results if a heavy short should develop on the 3-wire direct-current system?

Induction motor-generator set. A. Peters.

Rotary converters; circuit-breakers will protect generator.
Geo. W. Richardson.

Induction motor-generator set. W. H. C.

Motor-generator set, though cost is more.
A. E. Walden.

Induction motor-driven sets are preferable, as they are less liable to flash over on heavy short-circuits than are rotaries under the same conditions. They are preferable to synchronous motor-driven sets, as the self-inductance is greater and will prevent such an excessive flow of current in case of a short-circuit as would be the case with synchronous motors, and the consequent effect on other apparatus connected to the same circuit is less. It is also nearly impossible to burn off even a small short-circuit with 60-cycle rotaries, but is possible with motor-driven generator sets whether they are synchronous or induction motors.
W. F. Oviatt.

There are two points to be considered:

First—The machine most effective in quickly burning off the ordinary short-circuit on feeder or mains.

Second—The machine that can be most quickly put back on load if the short-circuit has been severe enough to necessitate shut-down of unit.

In regard to the first, as between shunt-wound rotary converters and shunt-wound generators driven by induction or synchronous motors, the rotary converter is most effective in burning off an ordinary short-circuit, as it will maintain nearly constant voltage with excessive overloads, whereas, the shunt-wound generators will drop off very rapidly in voltage.

In regard to the second, the smaller-size induction motor-driven generator sets could undoubtedly be put back into service more quickly than a rotary or synchronous motor, both of which have to be synchronized. For the larger sizes of induction-motor generator sets, say above 500-kw capacity, there would be very little, if any, difference in time required to put machines under load.

As a general proposition the rotary or synchronous motor-generator would for the above reasons, as well as for better efficiency, be advisable for the larger systems, while the induction motor-generator could sometimes be advantageously used in the smaller stations. W. A. Rollins.

Induction motor-generator set. All three types of motors will pull out on short, but the chances are in favor of induction motor being up to speed and able to take load sooner than other type. Harry Hollis.

Induction motor-generator sets in this particular case.
Harry M. Hope.

Induction motor-generator sets. A. R. MacKinnon.

In case of a heavy short if the direct-current apparatus is protected by proper circuit-breakers there should be no trouble in any case, but if not so protected the induction motor would probably pull the longest with the short on.
C. W. Higgins.

Induction motor-generators would furnish current longer under severe short-circuit conditions; that is, they would not be affected by drop in voltage to such an extent as would synchronous motor-generators or rotaries, which would almost immediately drop out of step under severe conditions.
The Edison Elec. Ill'g Co. of Boston.

Induction motor-generator sets.
The Edison Elec. Ill'g Co. of Brockton.

An induction motor-generator set would probably cover the conditions that would result from heavy short-circuit on direct-current end better than either of the other types of apparatus mentioned, as the induction motor will take care of an extremely heavy overload, anyway, and the motor can not be injured by a dead short-circuit; the only effect such a condition would have would be the slowing down of the motor. The general efficiency of such a set would probably be about the same as that of either of the others. F. G. PROUTT.

K 11. (a) What is the probable difference in cost and efficiency at one-half, three-quarters and full load between using static transformers and a rotary converter and using a synchronous motor-generator set, the motor taking full alternating-current voltage, say 6600 volts? (b) What is probable difference in case of an induction motor-generator set?

The efficiency will be least with rotary converters. GEO. W. RICHARDSON.

Only an approximate comparison can be made in this case. The costs are affected by the frequency to a certain extent. Taking 25 cycles, for instance. The rotary converter for a given cost should have at least as great an output as the generator of the motor-generator set. The efficiency of the rotary should be probably two per cent greater than that of the generator at full load, and from two to four per cent at one-half load. It then remains to compare the cost and efficiency of a synchronous or an induction motor with that of the lowering transformers. Rough comparison would indicate that the synchronous and the induction motor for the above conditions should cost very nearly the same, and the efficiencies of these two should be practically the same unless the induction motor is designed for rather good starting torque. If the induction motor is designed for a very small slip and consequent small starting torque, its efficiency can be made relatively high.

The cost of a synchronous or an induction motor will always be considerably higher than that of the lowering transformers required in the above case. This cost may be even two or three times as great. Therefore, the combined cost of the motor-generator set should be very considerably greater than that of the rotary-converter set with equally good operating machines.

Efficiency of the synchronous or the induction motor will usually be from three to five per cent lower than that of the lowering transformers. Therefore, the efficiency of the motor-generator unit should be from five to seven per cent lower than that of the rotary converter with its lowering transformers, and the difference may even be greater in small units.

In the case of 60-cycle rotary converters the difference will not be as great, as the efficiency of the 60-cycle rotary converter will be possibly equal to or lower than that of the direct-current generator of the motor-generator set. On the other hand, the efficiency of the 60-cycle synchronous or induction motor may be slightly lower than in the case of the 25-cycle unit. As the transformer efficiency will not be reduced the same amount, the combined efficiency of the 60-cycle motor-generator will be slightly lower than that of the 25-cycle set, while the efficiency of the 60-cycle rotary-converter set will be lower than the 25-cycle set, but the reduction in the efficiency of the rotary set will be one or two per cent greater than in the motor-generator set. It may be said, in general, the efficiency of the 60-cycle motor-generator set will be from three to six per cent lower than that of a 60-cycle rotary-converter set.

THE WESTINGHOUSE ELEC. AND MFG. CO.

K 12. What are the points in favor of use of air compressors for central-station use for cleaning dynamos, etc.?

Compressed air reaches portions of machines inaccessible by other methods, can be applied while generators are in service, and has the double advantage of thoroughness and facility of handling. RALPH R. LAXTON.

The advantage of using compressed air for cleaning purposes in central stations is readily seen in the case of armatures of considerable size, where with a nozzle of some length dust can be blown from coils and leads that are entirely inaccessible to a bellows or cleaning by hand. LEE BOYER.

Using an air compressor for station use in cleaning out dynamos, *et cætera,* is more desirable than any other method, as it is a labor-saving device; it is also much more efficient, dust and dirt in holes and corners of the machines being driven out where a hand-bellows would never touch it, and the man in charge of cleaning the machines is apt to do his work much better than by using the hand-bellows. WILLIAM M. LEWIS.

Air compressors furnish an easy and convenient method of cleaning dynamos. The work done is also superior to any other method of cleaning known to us.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

The air compressor in a station is really a necessity and no station of any size should be without one, especially where it runs twenty-four hours in every day. If you use your air hose in the proper manner and do not get it too close to your mica insulation, you will have no trouble at all, but you can in a short time blow a great portion of the mica out of your alternators and leave them in a weak condition. By using your air for cleaning your fields and armatures as well as the frame, you always have a machine looking as though it were new, as the air does not affect the varnish where soft rags are used to wipe the machines after all the dust has been removed.

Where you are called upon at times to overload your machines for a few hours you will find it an easy matter to simply tap your hose with two nozzles and put them to blowing on each side of the machine to keep the temperature down and prevent hot boxes. Again, where you have a hot box, though it may be smoking, you can easily cool it down with compressed air from your compressor, as compressed air has a very dry, cooling effect and does not affect your generator; but care should be taken not to blow all your oil out. For cleaning switchboards it is ahead of everything, as there is no danger of a short-circuit and you are sure to have a good clean board. Your arc lamps, and also your meters, can be cleaned in a few seconds by piping your air to your repair-room, and your torches kept at a steady flame from its regular pressure when stored in a reservoir.

FRED M. LEGE, JR.

Air compressors are handy for cleaning dynamos, exciters, switchboard for pneumatic control, for air drills, and for forcing oil to different bearings. AUGUSTA RY. AND ELEC. CO.

(1) Is not dangerous to workman or injurious to machine.

(2) Reaches all parts of machine.

(3) Can be used while machine is running.

(4) Does the work quickly and leaves no lint or moisture on machine. R. McMillan.

The thoroughness of the cleaning. W. P. Hancock.

The use of air for cleaning electrical machinery shortens the time required to do the work and enables the operator to do a much more thorough job. It is possible to clean out corners and the recesses that can not be reached by other means.

I. E. Moultrop.

K 13. (a) What is considered as the working life on a 125-volt, 300-kilowatt, moderate-speed direct-current commutator? (b) What is annual expense for carbon brushes?

The working life of a 125-volt, 300-kw, moderate-speed, direct-current commutator depends almost entirely upon the care and attention given it. Presuming the machine is of first-class make, and that proper care is given to commutator, the life should be, at least, ten years.

Charleston Consol. Ry., Gas and Elec. Co.

(a) About ten years. Carbon brushes ought to last six months to a year in this service. Augusta Ry. and Elec. Co.

I operate two 150-kw, two 100-kw and two 56.5-kw, all 125-volt, direct-current generators and the commutators have been run for three years and show no great wear; they have never been turned down and but one new set of brushes has been placed on them. These machines average twelve hours a day each, and are well loaded, but are never allowed to spark in the slightest and the commutators bear a rich chocolate color, being well lubricated and always receiving the closest attention.

Fred M. Lege, Jr.

K 14. Is it practicable to overload an incoming generator on a water rheostat and thus lower its frequency, in order that it may be synchronized with a generator that is overloaded and running below speed?

It is practicable, and the writer has resorted to such a procedure in the operation of a hydro-electric plant consisting of two 1000-kw units. L. O. VESER.

Practicable, perhaps, but by no means to be recommended. The second unit should be thrown in before the load is so heavy as to reduce the speed of the first prime mover, and to reduce the speed of the second by an artificial overload would be to invite disaster. RALPH R. LAXTON.

It is entirely practicable to overload an incoming generator on a water rheostat, thus lowering its frequency, in order to synchronize it properly with a generator that is already overloaded and running below speed. In Germany, when the question of paralleling alternators first came up, water rheostats were quite commonly used, it being the belief at that time that the facility with which machines could be thrown together was increased by loading up the incoming generator in this way, the load also being used more or less for obtaining the proper speed.
H. H. BARNES, JR.

This depends upon your switchboard attendants, and you are always taking chances. AUGUSTA RY. AND ELEC. CO.

This is practical, but should not be necessary, as it is not difficult to slow down the incoming engine by means of the governor or throttle. M. P. R., N. Y. ED. CO.

K 15. In the operation of alternators in parallel, driven by reciprocating engines and turbines, is there any tendency shown for the turbine sets to take all or nearly all the fluctuations of the station load?

The division of the load between reciprocating engines and turbine-driven alternators in parallel depends entirely on the respective governors. By a proper choice of governor, either the turbine-driven or engine-driven units may be made to take the greater share of the load fluctuations.

H. H. Barnes, Jr.

A very good discussion of this appears in the *Electric Club Journal*, February, 1905. A. Balsley.

With steam turbines operating in multiple with reciprocating engines, the standard adjustment of turbine governors will usually force the turbo set to take practically all of the fluctuations This can be corrected, to a large extent, by altering the adjustments of the various governors, but the inherent close regulation of the steam turbine will always force it to take more than its proper share of the load.

M. Carrington.

In case the generators have similar characteristics as regards regulation, then the question of division of load between the above units will be principally a question of flywheel characteristics of the two units and the engine characteristics. Turbo-generators very frequently have large flywheel capacity and may not follow quickly the changes in the slow-speed engine conditions due to the great inertia of the turbo-generator field. Also in many instances the speed regulation of the reciprocating engines has been made comparatively poor in order to assist parallel running, while steam turbines may be designed for much better speed regulation, as it is not necessary to make the governing of such units sluggish to assist the parallel operation. In consequence, it may happen that a turbo unit with great inertia and good speed regulation characteristics may be operated in parallel with reciprocating unit having much smaller inertia and much poorer speed regulation. In such a case the turbo unit will take the fluctuations of the load to a considerable extent. If the turbo unit were replaced by reciprocating unit having similar inertia and speed characteristics, this latter unit should also take the fluctuations in a similar manner.

The Westinghouse Elec. and Mfg. Co.

Steam turbines will take a little more than their proper share of fluctuations on station load.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

K 16. In the operation of alternators in parallel, driven by reciprocating engines and turbines, what tendency, if any, is shown for a heavy cross current at time of sudden overload or short-circuit?

In operating reciprocating engine and turbine alternators in parallel the tendency is for the turbine to take the overload, providing the regulation of the alternators is the same.

EDW. SCHILDHAUER.

Answer to question K 15 should cover this. The same cause that could make certain of the units take the fluctuating loads would also make the same units give heavy cross currents under extreme conditions.

THE WESTINGHOUSE ELEC. AND MFG. CO.

In the case of two large plants operating in parallel, one engine-driven, the other turbine-driven, no serious troubles of the kind mentioned have been noticed from overloads or short-circuits. (UNSIGNED.)

K 17. (a) What is found to be the best method of grounding the star point of large (1000-kw or over) generators—grounding through one rheostat common to all machines, each generator through separate rheostat, or otherwise, and (b) what sort of rheostat or connection to ground is best?

(a) In the design of large power stations it has generally been conceded that the best practice is to provide a single rheostat which is common to all generators in the station, this rheostat being designed to limit the current in the common ground lead to a certain predetermined amount. This current is decided upon by the conditions existing in the installation, and the grounding is primarily for the protection of the feeder circuits.

(b) The resistance is usually made of heavy grids of resistance metal mounted in suitable frames, the whole being supported on insulators suitable for the required voltage.

BERTRAND ROWE.

K 18. In motor-generator sets consisting of a polyphase motor and direct-current or alternating-current generator, what advantages have induction over synchronous motors?

In small or moderate sizes induction motor would probably have the advantage in first cost over synchronous. Has fewer accessories and requires somewhat less care in operation, particularly in starting. It is also free from "hunting" sometimes found in synchronous installations, but in larger sizes, representing considerable percentage of the capacity of generator or lines, its low power factor must be reckoned with and it is at a decided disadvantage in that it has not the valuable property possessed by the synchronous motor of correcting the power factor of the line. An induction motor-generator set is also inferior to synchronous set or rotary converter in that it is not capable of being used "inverted." RALPH R. LAXTON.

The principal advantage that an induction motor has over a synchronous motor is that in case of lightning troubles on the alternating-current system the induction motor is not seriously affected, whereas a synchronous motor will fall out of step. In case of a lightning discharge through the arresters, it has the effect of momentarily diverting the current. This is a serious matter in operating units in parallel. I should recommend induction motors wherever there is lightning trouble.

H. J. GILLE.

The advantages of an induction motor over a synchronous motor are its higher breakdown point, and also that it can be started without any auxiliary apparatus. These advantages are overweighted by the better power factor of the synchronous motor, which is an important feature. H. J. MEYER.

Induction motors will operate, even after one phase may be open-circuited after they are started, and also work better on variable voltage on the different phases.

AUGUSTA RY. AND ELEC. CO.

The main advantages are the ease of starting the induction motor, the low cost of necessary switchboard, the fact that it will not "fall out of step," the fact that there are no moving contacts and the fact that no exciting current is necessary.

See *Electrical Club Journal,* February, 1905.

W. R. Collier.

Synchronous motor-generator sets may be used to raise the power factor of the system, while induction motor-generator sets will, of necessity, lower the power factor; but where the attendance is not thoroughly competent more harm than good will probably be done in attempting to adjust the field strength of the synchronous motor for obtaining the best results.

An additional disadvantage against the synchronous set lies in the fact that in order to cut down line disturbances at starting it is necessary to provide some external means of bringing the unit up to the synchronous speed, and this is usually accomplished by an induction motor.

The cost of the induction motor-generator set will usually be considerably lower than that of the synchronous motor-generator set, especially where the installation is fed through transformers, allowing one-half voltage taps to be taken out for starting and thus eliminating the auto-starting device.

M. Carrington.

Simplicity of starting devices and absence of exciter.

Absence of field rheostats and instruments.

Rugged construction throughout.

Motor starts with load and without friction clutch.

Running current not dependent upon attendant, or wave form.

Power factor not changing with wave form or excitation and there is no hunting.

Does not react upon generator as does the synchronous type.

Changes in generator speed and in load readily taken care of.

Skilled attendance not necessary and the apparatus is simple both in construction and operation.

The Philadelphia Elec. Co.

Induction motors are not affected by drops in line pressure to such an extent as synchronous motors, and are generally capable of standing overload conditions with less liability of trouble. They are also generally easier to operate, being easier to start and place in service on a large system.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

The induction motor requires no exciter with the switchboard apparatus incident to it. It is simpler in construction, has no field winding with liability of "field discharge." It has no rotating winding other than the squirrel secondary. It is easier to start, takes less starting current, and does not have to be synchronized. It is not overloaded and stopped if the voltage of the supply circuit falls momentarily or if there is a heavy load or short-circuit on the generator. As it has no field adjustment, the operator can not disturb the voltage or power factor of the circuit. Accidents that would injure the motor or interfere with the service are much less likely, and satisfactory operation can be secured with a lower grade of labor. THE WESTINGHOUSE ELEC. AND MFG. CO.

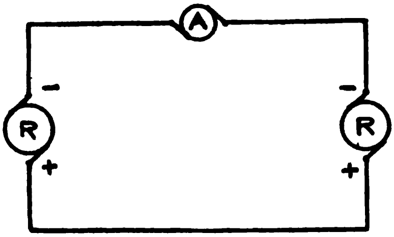
Induction motors are easier to start; do not go out of step and cause all kinds of trouble in case of a momentary short-circuit on the system supplying motor; do not feed back into a short-circuit on supplying system; are much more reliable and easier to operate. When used to operate alternating generators in parallel it is much easier to divide the load properly between the generators when same are driven by induction motors.

M. P. R., N. Y. ED. CO.

K 19. Is it practical to use a Hopkinson, Kapp or other similar test on two 6-phase rotaries in the substation, connected to run normally in multiple from the same 'bus-bars, which are supplied by a 3-phase line, a separate engine being available at the generating station? Assuming first that their shafts can not be interconnected; and, second, that they can be interconnected. Give description of method or connections.

If induction regulators are available for varying the direct-current voltage, one rotary can be run inverted by adjusting the regulators, and a full load placed on each rotary.

If induction regulators are not available, the test can be made by means of an auxiliary machine having an ampere capacity equal to that of one of the rotaries and capacity in kilowatts equal to the copper losses in the two rotary outfits. The two rotaries should be started and direct-current voltage equalized at the desired value for the test. Then the auxiliary machine should be connected as shown in the diagram and the field of this machine be adjusted to secure the desired current in the armatures of the rotaries. D. W. Roper.



L

STORAGE BATTERIES AND BOOSTERS

L 1. What is the value of storage batteries floating on exciter circuits?

They serve to maintain uniform load on exciter.
W. H. Greenslit.

Perfect operation of plant if exciters give out. A. Peters.

Valuable in cases where exciters are all driven by induction motors and where all alternating-current units are in parallel. Their use is not recommended except in the large station where they may be properly charged and discharged. W. H. C.

If properly equipped with circuit-breakers, guarantees a practically uninterrupted exciting current for generators.
Harry Hollis.

Close regulation and reliability of service insured.

G. WILBUR HUBLEY.

Insurance of service and means for rapid starting in event of a shut-down.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

The functions of these batteries may be grouped under three headings: First, regulation. Second, emergency discharge for excitation. Third, emergency discharge for lighting.

Under the first heading, batteries are especially desirable for maintaining constant voltage on the exciter 'bus, notwithstanding irregularities in the operation of the exciter units. These irregularities are particularly liable to occur where current for excitation is supplied by rotaries or motor-generators operated from the alternators themselves. In this case, any tendency to change the speed of the alternators will vary the voltage of the exciter 'bus in the same direction, thus magnifying the effect on the alternator voltage. In order to obtain the best results from a battery used for this purpose, the exciter sets should have a drooping characteristic so that their voltage will be held at the proper point with the least amount of charge or discharge in the battery.

Under the second heading, a battery is of special advantage for emergency discharge, since it is always ready to take its load, no time being lost in getting it into service. Should trouble appear with any one of the exciter units, it can be shut down instantly and its load thrown on the battery until another unit can be put in service. In this way any derangement that may be of minor importance at first, may be prevented from becoming more serious. In case the entire exciter load is carried by one unit, a breakdown of this unit causes a total interruption of the station output if there is no battery floating on the exciter 'bus. Where the exciter current is furnished by rotaries or motor-generator sets, an interruption of this kind must continue until a steam-driven exciter can be put into service, if there is no battery, since there is no alternating current available for operating a motor-driven set.

Under the third heading, a battery on the exciter 'bus is of great advantage in supplying light for a station in case of any accident that would interrupt the operation of the plant and otherwise put the entire station in darkness. Even with a steam-driven exciter this result might ensue, due to an accident to the boiler plant or steam piping. J. Lester Woodbridge.

Invaluable as an insurance of continuous service.
H. Bottomley.

It is small. Very often they will make an undesirable complication; especially when the exciters are compound wound. The more reliable the exciters are, the less are the storage batteries needed. W. H. Wolvekamp.

L 2. Does it pay a small plant to install batteries? What is the depreciation of storage-battery installations?

(a) Yes; storage batteries are a paying investment where single-expansion engines are used and fuel is high.

(b) Depreciation is very slight. W. H. Greenslit.

(a) Under certain conditions, yes. If a small plant sells current at flat rate, no.

(b) With care, depreciation is very little. A. Peters.

(a) It depends on nature of loads; usually the installation would not be justified.

(b) Depreciation is about 10 per cent under favorable conditions. G. Wilbur Hubley.

It depends upon the nature of the service. E. L.

Each case should be given specific consideration. In the abstract, many small plants now giving only night service could profitably furnish a 24-hour service by installing batteries for the daylight demand; these batteries also being available for assisting the generators during the peak hours, thus adding to the station capacity to meet increasing loads.
Chas. Blizard.

The depreciation of storage-battery installations depends largely upon the man in charge of the plant. If the simple instructions furnished for the proper care of batteries are followed, plate renewals for small installations, comparing favorably with isolated plants, should average about six per cent per annum of the cost of the battery installation.

JOHN R. WILLIAMS.

(a) Supposing that by "small plant" central station is meant, I should say, No.

(b) About 10 per cent is considered a fair average, but it depends a good deal on the kind of work the batteries are doing, and on the care they get. W. H. WOLVEKAMP.

L 3. Is it not more profitable for medium-sized plants to increase their station capacity than to put in storage batteries?

If a plant runs all day and the day load is light and uneconomical, put in a battery to carry day load and peak of night load. A. PETERS.

Yes. G. WILBUR HUBLEY.

As a battery may be discharged in multiple with the generators to take a portion of the peak load, it consequently increases the station capacity by the portion of the peak that it takes. As to whether the increase in the capacity of the main generating station should be made by generators or batteries, depends upon several factors, the most important ones generally being the shape of the peak and the values placed upon close regulation and upon the reserve furnished by a battery.

CHAS. BLIZARD.

In most cases it will be the best practice to increase the station capacity. If the generating units are very large compared with the average light load, the storage batteries will give a better load factor, but this gain will not compensate for the batteries' loss and expense. A very important fact is that spare station capacity is good for 24 hours per day at maximum load, and the batteries are only good for one or a few hours at maximum load at certain times. W. H. WOLVEKAMP.

L 4. What would be the original cost, cost of operation and cost of maintenance, of a set of accumulators to operate 200 16-candle-power, 110-volt lamps three hours?

The approximate cost of a battery of this capacity, installed on a three-wire system, with switchboard and without boosters, would be $3600. No additional labor would be required for its operation. CHAS. BLIZARD.

The answer to question L 2 applies to the maintenance feature of this question, and assuming the original cost as $3600, the cost of plate renewals should average about six per cent, or $216 per annum. JOHN R. WILLIAMS.

The original cost of the accumulators with their accessories may differ widely, according to the buyer's choice. The cost of operation, without labor of taking care of the batteries, will be approximately the cost of 66 hp-hours of the motive power. The cost of maintenance per year will be about 10 per cent of the batteries' cost price, but this is variable, according to the care they get. W. H. WOLVEKAMP.

L 5. What is the ampere capacity of a storage battery at high rates of discharge, say the 5, 10, 15, 20, 30 and 45-minute rate, in terms of the one-hour rate?

It depends upon the kind of plates, condition, formation and age. The twenty-minute rate is usually considered as being double the one-hour rate. E. L.

The above rates in multiples of the one-hour rate for plates specially designed for working at high rates of discharge are respectively as follows: 4.5, 3, 2.5, 2, 1.5 and 1.2 times the one-hour rate. It may be stated, however, that the extremely high rates are impracticable. HUGH LESLEY.

L 6. Can a storage battery be successfully connected to the Edison 3-wire system so that it will automatically charge or

discharge as the rise or fall of the current strength may demand, without the care of an operator at the substation?

Why not use differential boosters with batteries?

A. PETERS.

Yes. G. WILBUR HUBLEY.

Not very well, if close regulation is desired.

W. H. WOLVEKAMP.

The question evidently refers to a storage battery located in a battery substation at some distance from the generating station. To a certain extent a battery so located will discharge or charge with rise or fall of the load without any automatic regulation. The voltage, however, will not remain absolutely constant under these conditions, but will follow the voltage characteristics of the battery. To maintain constant voltage by automatic regulation would involve automatic control of the end-cell switch, since booster control would be prohibited, under such circmustances, without attendance. It would doubtless be possible to devise a method of automatic end-cell switch control which would respond to changes of voltage, thus producing the necessary charge or discharge of the battery required to maintain constant potential with varying load, by throwing end cells in or out. The state of perfection already attained in the development of remote control for end-cell switches, would indicate that this might be extended to produce the results above mentioned Nothing of this kind, however, has as yet been attempted, and there seems to be no immediate demand for such a scheme.

J. LESTER WOODBRIDGE.

L 7. Is there a formula, or what determines the ratio of storage-battery capacity to total connected load in large cities?

There is no formula, the battery capacity being governed solely by the opinions of the engineering force or the officials of the companies, and the investment that the companies in the various cities are willing to make for this insurance.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

There is no accepted formula, the percentage of battery capacity being fixed by local conditions. Battery capacities at the one-hour discharge rate vary from 15 to 40 per cent of the maximum direct-current load. CHAS. BLIZARD.

It seems to me that it depends upon the judgment of the manager and superintendent of the station. In order to determine the size of the batteries and number of cells, many points should be taken into consideration; such as what their work is going to be, size of peak of load, size of generator units, load factor, *et cætera*. W. H. WOLVEKAMP.

L 8. (a) What is the actual efficiency (energy) obtained from a storage battery, (b) the efficiency (quantity)?

About 70 per cent. G. WILBUR HUBLEY.

The efficiency depends on the rate of discharge and charge. In actual practice, making six tests on 140 cells (3-wire system) of 200 amperes for two hours capacity, I found at maximum charging rate 75 amperes and maximum discharge rate 200 amperes two hours on each side, the average ampere efficiency 81 per cent and the average watts efficiency 78 per cent (for batteries only). Figuring in the loss of energy in the motor for charging with two boosters, the watts efficiency dropped to 51 per cent. W. H. WOLVEKAMP.

The energy, or watt efficiency, of a central-station storage battery, under the usual service conditions, is from 70 to 75 per cent. The quantity, or ampere efficiency, is from 88 to 92 per cent. HUGH LESLEY.

L 9. Is it advisable to use recording voltmeters and ammeters in connection with the operation of storage batteries? If so, to what extent and for what purpose?

Recording voltmeter placed on a specified number of cells will give point of cut-off for charge. Recording ammeter will show action of batteries through 24 hours. It is especially advisable to install the voltmeter. A. PETERS.

Yes. Records of this kind are always valuable in keeping check on operator's care. W. H. GREENSLIT.

Recording voltmeters are necessary; recording ammeters are not. E. L.

Recording ammeter, and, better still, recording wattmeter with dial readings will be found a desirable instrument in many cases. It is a convenient check on how much the batteries have been discharging and approximately how much charge they want again. W. H. WOLVEKAMP.

Recording voltmeters have been in very general use for several years, and it has been thoroughly proven that they are of very great value in the proper operation of batteries.

Recording ammeters are used to a very limited extent and have not proved satisfactory as a guide in following the working of a battery, as the scale on these instruments is such that an accurate record of the wide variations of current can not be obtained. HUGH LESLEY.

L 10. Has a simple method been found for taking the acid fumes out of the air discharged from storage-battery rooms?

Draw air, by means of a disc exhaust fan, from the battery-room through a series of four or five fine brass screens (about 30 wires of No. 30 wire to the inch). Each screen should have an area of about double that of the exhaust-fan opening. E. L.

Acid fumes have been satisfactorily removed from the battery-room air in an experimental way, but in Boston an installation is now being made to filter the air in a large battery installation. I. E. MOULTROP.

This can be readily accomplished by passing the air through a material of fine mesh located in front of the outlet flue. By this method the air is thoroughly cleared of acid particles and is discharged free from all objectionable features. HUGH LESLEY.

L 11. What results have been obtained from use of board separators in storage batteries?

The results are very satisfactory on certain batteries.
E. L.

Board separators, properly prepared for use in storage batteries have proved of the greatest value in all cases where they have been installed. They not only improve the condition of old batteries, but when installed in new batteries serve to maintain them in good condition for a longer period than any other type of separator yet developed. In many cases the introduction of board separators has increased the life of the plates two years, and even more, where plate renewals would have otherwise been necessary. The development of the board separator has been one of the greatest improvements in the storage-battery art in recent years. HUGH LESLEY.

L 12. What methods are used in removing sediment from storage cells, and which is considered most satisfactory?

Use two scoops made of wood, well asphalted; make blade of one three and one-quarter inches long, the other, say, seven or eight inches or longer, according to width of cell. Scoop up all you can get with the short scoop, then use the larger one. You can also draw off acid, and if water is good and pure fill cell; and then, while water runs in at one side siphon off at the other, stirring up the sediment all the time. I think, while the scoop method is perhaps the slow method, the ordinary battery attendant will find it the best. A. PETERS.

Take elements out of cell, siphon off electrolyte and scoop out sediment. HARRY HOLLIS.

Remove the greater part of the acid, stir up the sediment by means of paddles and a strong force of water from a hydrant or pump. At the same time remove the sediment and water, by means of a pump, provided the siphon method can not be used. Run the water through a settling tank. Continue the process until all of the sediment has been removed. Refill with acid. Only a few plates have to be cut out when this method is followed, and none have to be taken out of commission. E. L.

One way is to scoop the sediment out at the side and from under the plates; but this is generally not satisfactory. The best method is to charge the cell, siphon or pump out the electrolyte, pour in water, stir the sediment, siphon out again, and repeat the operation till sediment is removed.

W. H. WOLVEKAMP.

The best method of removing sediment is dependent upon the size of the cells of a battery. For the smaller sized batteries it is usually most convenient and least expensive to withdraw the sediment from the bottom of the cells by means of a wooden rake or scoop. For batteries of larger sizes a siphoning or pumping method is used, the electrolyte being circulated through a system of tanks in which the sediment settles out.

HUGH LESLEY.

L 13. When a leak has once developed in lead-lined oak tanks, saturating the wood with electrolyte, and the leak in the lining been repaired, cells mounted on porcelain feet four inches high, will electrolytic action set in with a likelihood of pitting the lining from the bottom upward and rotting the wooden tank? If not, what is responsible for such action? If so, is there any known remedy other than the replacing of tanks, once they leak? It has taken place in a number of cells with entirely new linings but old tanks.

Yes. Best to put in entire new tank. Dry wooden tank thoroughly before new lining is placed, and coat heavily with a good insulating paint. I think pitting of lead lining is due to electrolysis. HARRY HOLLIS.

Once the cell leaks and the insulation is broken down through electrolytic action, the lead lining must be repaired and new supporting insulators installed underneath the tank. The fault is in the old insulators and not in the new lining or wood. In all probability the current leakage to ground goes through and not over the supporting insulators. E. L.

The electrolytic action was caused, perhaps, by iron screws that fasten to the bottom of the wooden tank the blocks that stand on the insulators. W. H. WOLVEKAMP.

In the case of cells where porcelain, or insulators, are used, there is likely to be a recurrence of electrolytic action and subsequent leakage in tanks in which the lining has been repaired if the insulators have become saturated with acid, as is frequently the case with cells that have once leaked. Simply washing the insulators with an alkaline solution has not proved sufficient to neutralize the acid they have absorbed, so that the only safe method to prevent recurrence of leakage is to substitute glass insulators for those of porcelain, which are very apt to be porous. HUGH LESLEY.

L 14. What paint or compound have you found most satisfactory for painting the outside of storage-battery tanks to protect them from the action of the acid fumes?

Asphaltum paint is satisfactory. Cells should be occasionally washed down with a strong solution of bicarbonate of soda and afterward wiped dry. E. L.

The most suitable compound for this purpose is a special paint known to the trade as "Improved Battery Black Paint," which has a high grade of asphaltum for a base.

HUGH LESLEY.

L 15. What are the relative merits of the booster and the end-cell switch methods for battery regulation on light and power systems? Is any lighting company using the booster method of a 3-wire Edison system?

Batteries are used very largely in Edison stations as a reserve and are consequently called upon in case of emergency to discharge at very high rates. Batteries never break down without having given ample warning, while on the other hand, generating apparatus or boosters may fail without having given any preliminary indications of trouble. This feature of the generator or booster has been one of the reasons why it has not been used to displace end cells. When a battery is called upon in cases of emergency, all of its parts should be equally reliable, and were a booster to be used in place of the end cells, such would not necessarily be the case.

I believe that there is one Edison company experimentally using a booster in connection with one of its batteries.

CHAS. BLIZARD.

L 16. In what order of importance do central-station companies regard the functions of their storage batteries? (a) Regulation. (b) Taking of the peak load. (c) Emergency reserve.

(1) Emergency reserve.
(2) Taking the peak load.
(3) Regulation. A. L. LANDSBERG.

I should say that the relative order of importance is as follows:

(1) Emergency reserve.
(2) Regulation.
(3) Taking care of peak load. H. T. HARTMAN.

Emergency reserve. Peak load. Regulation.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

In the larger plants—reserve, first; peak work, second; regulation, third. In the smaller plants, peak work or regulation is generally given first place. CHAS. BLIZARD.

L 17. What should be the ratio of the battery capacity at the one and one-quarter hour rate to the total generating capacity in central-station systems?

There is no fixed ratio, the proportion of battery capacity to total direct-current load being fixed by local conditions. In this country, battery capacity at the one-hour rate of discharge varies from 15 to 40 per cent of the maximum direct-current load.

CHAS. BLIZARD.

For the Chicago companies the ratio is between 25 and 30 per cent. GEO. E. MCKANA.

L 18. When sulphate forms on plates, what is the best method for removing it?

If a battery has been overdischarged to such a point that sulphate has become visible on the plates, it should be recharged at a low rate, the charge being continued until all the evidences of full charge are present. Several charges may be required before the plates regain their normal appearance. In some cases there is a thin film of sulphate on the surface of the plates, particularly the negatives, which may be broken up or scattered over the surface of the plates, which overcharge does not reduce. If this coating easily falls off when touched with a stick, showing the proper plate color beneath, the cells have been restored to proper condition, and it is unnecessary to further endeavor to reduce the sulphate scales. HUGH LESLEY.

Try a very low charging rate. W. R. COLLIER.

The normal chemical reaction that takes place in a storage battery while discharging is the production of lead sulphate on both plates. This is what may be termed healthy sulphating; but there is a condition in which a whitish scale forms on the plates, and plates thus coated are said to be dangerously sulphated. A plate in this condition is incapable of giving good service.

The conditions under which this objectionable sulphating is likely to occur, are as follows:

(1) A cell may be overdischarged, that is, completely run down, and left in this condition for some time.

(2) It may have been left partially discharged for some time even though the limit has not been reached.

(3) The electrolyte may be too strong.

(4) The electrolyte may be too hot.

(5) A short-circuit between the plates may cause a cell to run down on open circuit and when the battery is charged the cell will receive only a partial charge as compared with the rest of the battery.

Some of the sulphate may be removed by carefully scrubbing the plates with a brush. The cell may then be charged at a low rate (about one-half normal) for a long period. By fully charging and only partially discharging for a few times, the unhealthy sulphate is gradually reduced. When the cells are only slightly sulphated the latter treatment is sufficient without scrubbing. When the cells are very badly sulphated, the charge should be at about one-quarter the normal rate for several days, with frequent intermissions of a few hours.

GEO. T. SEXTON.

M

SWITCHBOARDS, INSTRUMENTS AND STATION WIRING

M 1. What one particular feature in your switchboards, instruments and station wiring has been the greatest danger to reliability (a) to service from your station? (b) From your substation? (c) What remedy did you apply?

(a and b) Fuses. (c) Adopted General Electric expulsion fuse. W. H. GREENSLIT.

The grounding of the feeders from the generators to switchboard, due to the iron-pipe conduit not being lined, although the cables were okonite insulation with an additional covering of circular-loom over cables. GEO. W. RICHARDSON.

Our particularly bad feature was the breaking down of insulation on our primaries by lightning, which got into our board on the pressure wires. Our remedy was to better the insulation and put lightning arresters on the pressure wires.

L. E. WATSON.

The greatest danger we have noticed in the past is the possibility of forgetting to throw in the equalizing switch, which is on a separate pedestal.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

(a) Dirt on the switchboard and sticking of circuit-breakers. (c) Careful attention to these details will remedy any danger therefrom. AUGUSTA RY. AND ELEC. CO.

M 2. What are the principal troubles likely to occur with remote-controlled oil switches for pressures above 5000 volts? To what causes have failures of oil switches to open circuits been attributed?

One of the principal troubles arises from moisture in the oil. This, of course, can be remedied by care in obtaining only pure oil and seeing that it is not exposed before placing in the switch. Where tanks are not filled to the proper level trouble has been experienced, in some cases, by air bubbles being drawn below the surface when the switch was opened. The presence of air in the oil lowers the dielectric strength and tends to facilitate starting arc across the terminals. In the best types of switches now on the market this trouble is practically obviated by contracting the insulating lining of the tanks to approximately the outlines of the terminals and using the switch rod as a barrier between the terminals.

The cause of failure to open-circuit can usually be traced to freezing of the contacts. Contacts should be so designed as to give the maximum amount of spring contact with a slight rubbing action, tending to keep the surfaces in good condition. In the larger sized switches, which are shipped knocked down, care should be exercised in lining up very accurately so that full benefit may be obtained from the contact area provided.

Switches should also be designed with positive and direct action, and the open position should be maintained by gravity.

Means should always be provided for opening the switch by hand in case of failure of the control circuit from any cause.

M. CARRINGTON.

M 3. What success has been attained with the "horn-type" high-tension open-air switch? Does not above switch throw considerable strain upon apparatus?

Any switch that will prolong and extend an arc will cause increased rise in potential, consequently the effect of horn-type switch is a strain on the apparatus. EDW. SCHILDHAUER.

M 4. Are soapstone structures necessary in 'bus-bar installations of high voltage and large power?

Not absolutely necessary, but should think it good construction. F. C. S., MALDEN ELEC. CO.

Some form of fireproof structure is necessary. Reenforced concrete is better for this work than soapstone, having the advantage of greater mechanical strength, is much cheaper, and is its equal as a dielectric. HARRY M. HOPE.

They are advisable, but under some conditions could be done away with. THE EDISON ELEC. ILL'G CO. OF BOSTON.

The 'bus-bars for the high-voltage system should be enclosed by a fireproof material and something that is not seriously affected by the electrical action. It does not necessarily call for the use of soapstone. I. E. MOULTROP.

M 5. Should switchboards of large stations be made self-explanatory; i. e., have the connections diagrammatically indicated on the face?

No; they should be so arranged as to eliminate, as nearly as possible, the danger of developing short-circuits by throwing of switches. W. H. GREENSLIT.

It is well to have diagrammatical indication of the principal connections of a large station wherever there is considerable remote-controlled apparatus. B. JAMIESON.

Yes. This is in most cases omitted where some individual thinks he has a mortgage on the job. GEO. W. RICHARDSON.

Yes. F. C. S., MALDEN ELEC. CO.

Yes. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

The value of diagrammatic connections on the face of switchboards lies chiefly in the information it furnishes new operators, it being noted that after a short time skilled operators pay little attention to the diagram.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

It is very desirable to have a diagram showing connections, framed and kept near switchboard.

J. T. COWLING.

M 6. Is it not the best policy to have your switchboard very simple—to eliminate fuses and circuit-breakers?

See answer to K 5. C. F. HAYWOOD.

The simplicity of all connections in wiring is an extremely desirable feature, and in some remote instances it may be desirable to eliminate protective devices, such as fuses and circuit-breakers. This is particularly true in cases of machines that are so designed that they will carry only a certain amount of overload, and beyond this point cease to supply an excessive current, hence can produce no injurious overheating.

Generally, however, it is necessary to protect, in the most efficient manner, valuable apparatus which can be injured by an overload. Especially is this true of subfeeder circuits where excessive trouble on such subcircuits will automatically cut out that circuit and not interfere with the operation of the rest of the system.

It is better practice to complicate the wiring on the board a little more and protect the individual circuits as well as the main circuits, rather than to risk a disastrous trouble, which may result from a very small cause, but may spread on the switchboard and possibly involve the entire apparatus. E. W. GOUGH.

Yes. Eliminate fuses but not circuit-breakers.

F. C. S., MALDEN ELEC. CO.

Yes; but fuses and circuit-breakers are necessary.

W. H. GREENSLIT.

I would say, by all means use circuit-breakers and fuses of the enclosed type on rear of board. A. PETERS.

Yes; it is desirable to simplify as much as possible, but fuses or circuit-breakers as protective devices are essential.
G. WILBUR HUBLEY.

No. G. H. CUSHMAN.

We believe a switchboard can not be too simple in arrangement, but think the protection afforded by fuses and circuit-breakers very important. A. R. MACKINNON.

Fuses should be eliminated except on potential transformers and circuit-breakers should be retained only on feeders.
C. W. HIGGINS.

Yes; it is advisable to make switchboard simple, omitting fuses as far as possible, but not omitting circuit-breakers of reliable pattern. CHAS. H. PETERS.

The Denver Gas and Electric Company has eliminated all fuses and breakers from the alternating-current board, causing a great improvement in its service. H. S. RUSSELL.

Simplicity is desirable, but circuit-breakers should not be eliminated. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

No. AUGUSTA RY. AND ELEC. CO.

It is very desirable to have switchboards as simple as possible, but not to the extent of leaving out any necessary or really useful devices or instruments. Unnecessary fuses or circuit-breakers are a nuisance. M. P. R., N. Y. ED. CO.

A simple switchboard is much to be desired, but the elimination of fuses and circuit-breakers is an impossibility in an alternating-current system if reliable and continuous service is to be supplied. THE EDISON ELEC. ILL'G CO. OF BOSTON.

M 7. Is it standard practice to place fuses in the primary connections of pressure transformers supplying switchboard voltmeters, wattmeters, etc.?

Pressure transformers, supplying switchboard voltmeters, wattmeters, *et cœtera*, are not always fused on the primary side, but in case a serious trouble develops on one of these transformers it may spread to other circuits of far greater moment. The short-circuiting and arcing of a small potential transformer may start a fire that would prove very disastrous and far-reaching. Generally speaking, therefore, it would be better practice to fuse the primaries of these transformers, and such practice is very largely carried out in modern installations. E. W. GOUGH.

No. W. H. GREENSLIT.

Yes. G. WILBUR HUBLEY.

Yes. LOUIS I. PORTER.

Yes. C. A. KEELER.

No. F. C. S., MALDEN ELEC. CO.

Yes. FRED B. SHARPE.

Yes. G. H. CUSHMAN.

Yes. HARRY M. HOPE.

Yes. A. R. MACKINNON.

We have found it good practice to fuse potentional transformers. In a number of instances we have lost only the fuses, and several times lost both transformer and instrument when transformer was not fused. THE COLORADO SPRINGS ELEC. CO.

It is good practice. H. S. RUSSELL.

It is done here (Denver) with good results.
C. F. HAYWOOD.

Yes. J. F. DOSTAL.

Some companies use fuses on pressure transformers, but many do not. A set of fuses should be placed on the primary to lessen the danger from fire in case of a short-circuit in the transformer. A short-circuit in a transformer without fuses would mean a bad burnout and a great possibility of hot metal setting fire to the building or surrounding insulation.

A. M. COVER.

Yes. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

We feel safer in doing it and sometimes have occasion to replace fuses on account of lightning.

AUGUSTA RY. AND ELEC. CO.

M 8. Is it safe to operate a skeleton wooden board with a potential of 2000 volts, having the wires well insulated and using oil switches?

Yes. J. F. DOSTAL.

Wooden skeleton switchboards operating at 2000 volts where the wire is insulated for this pressure and where the switches are enclosed, should meet all the necessary safety requirements, provided the wiring be suitably mounted on porcelain; marble or slate panels, however, would be preferable. E. W. GOUGH.

Yes. W. H. GREENSLIT.

Yes, for temporary service; but for permanent installation, no. G. WILBUR HUBLEY.

It would be safe to a certain extent, so long as there was no arc formed to cause a fire, but a slate or marble board is much more practical and safe. F. C. S., MALDEN ELEC. CO.

Have operated a skeleton wooden board for five years on a potential of 2200 volts without the least trouble.

E. W. CROCKER.

Yes. FRED B. SHARPE.

Yes. G. H. CUSHMAN.

Perfectly safe. A. R. MACKINNON.

Well-designed wood switchboards are safe if properly treated with paraffin. THE COLORADO SPRINGS ELEC. CO.

It is safe to operate a skeleton wooden board on 2000 volts with oil switches, but would hardly be approved by underwriters.

C. W. HIGGINS.

Yes. We have a 2000-volt skeleton-board in use, but do not recommend the use of skeleton-boards.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Yes. There are many such installations in use operating in a perfectly satisfactory manner; in fact, if suitably wired with wire having slow-burning insulation and the wood treated with fire-proofing material, there is no reason for not considering such an installation a perfectly safe one.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

A properly designed skeleton wood board, with ample space for switches and wires, should be quite safe.

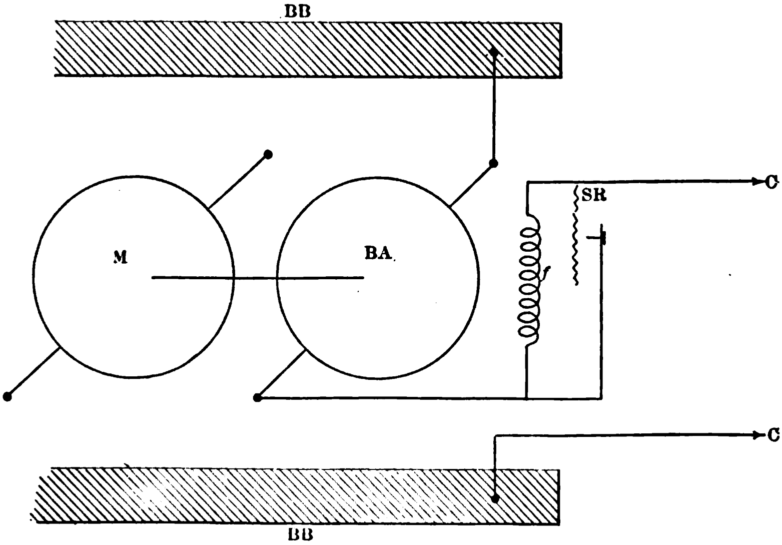
AUGUSTA RY. AND ELEC. CO.

It is not safe to have any wood about a switchboard.

M. P. R., N. Y. ED. CO.

M 9. Is there any satisfactory and economical method of feeder regulation for direct current?

The accompanying sketch shows a method of direct-current feeder regulation by means of a motor-driven booster.



The field coils and the armature of the booster are connected in series with the feeder, which makes the regulation almost automatic, as the volts generated and the volts lost in the feeder vary with the current in the feeder. WM. McDONALD.

Yes. GEO. W. RICHARDSON.

M 10. How do you obtain satisfactory regulation on alternating-current 60-cycle distribution system? Do you use hand or automatic regulators?

Hand regulators; using adjustable resistance shunted around generator compounding. W. H. GREENSLIT.

Have used General Electric M. R. regulators and found them most satisfactory. A. PETERS.

Hand primary regulators are most reliable and satisfactory.
G. WILBUR HUBLEY.

Hand regulation. F. C. S., MALDEN ELEC. CO.

Automatic regulators are the best. G. B. LELAND.

The most satisfactory regulation is obtained by automatic regulators. C. W. KOINER.

Hand regulators with lighting service predominating.
W. H. C.

Hand regulation in each feeder and governed by compensating voltmeters. A. E. WALDEN.

Hand-operated regulators are used, resulting in regulation within two per cent of normal. Automatic regulators are not sufficiently reliable to be satisfactory as yet.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

Use a hand-operated regulator on each single-phase lighting primary. THE SEATTLE ELEC. CO.

We have found the use of the Tirrell voltage regulator very satisfactory. It has reduced the cost of lamp renewals to us, and is vastly superior to hand regulation.

E. F. MCCABE.

If this question refers to holding constant the voltage on a 60-cycle generator we unhesitatingly say—install a Tirrill regulator. This apparatus regulates by short-circuiting the resistance in the field of the exciter and cutting it all out, or cutting in enough to reduce exciter voltage to about 45 volts. We have had one installed on one leg of our three-phase generators for over twenty months, and it has held voltage on that leg absolutely steady as load has come on and off; even the sudden variations of load due to the street cars do not affect our voltage perceptibly unless for some reason the regulation of our engine is extremely poor. Whenever we have had trouble with our lights it has always been due to the governor needing attention. Our experience is that it is a wonderfully reliable and quick-acting instrument. Our engineer never touches the rheostat. W. H. THOMSON, JR.

Hand regulators. FRED B. SHARPE.

We have recently installed an automatic regulator at our power-house, which has proven very satisfactory. The throwing on or off of motors does not affect the lights enough to be noticed, voltage not varying over two volts at the power-house.

H. N. CRANDALL.

Hand regulators. G. H. CUSHMAN.

Hand-operated induction regulators. HARRY M. HOPE.

We use hand regulation.
THE COLORADO SPRINGS ELEC. CO.

We use a compensated machine, which is very satisfactory, with a very little hand regulation. L. E. WATSON.

Satisfactory regulation is obtained by the use of pressure regulators. We have three-phase current from machine to switchboard, and distribution from board is single-phase. A regulator is placed in each circuit, the primaries of which are connected across the 'bus-bars and the secondaries in series with the feeders. By partially cutting the winding in or out on the secondary of the regulators, the voltage is readily adjusted. They are hand-controlled. SAM'L KAHN.

Have load well balanced, and use pressure, wire from centre of distribution, three-wire secondary, of heaviest district. Hand regulation. Where this will not give satisfactory results, install boosters in long-circuits, or use hand regulators in each circuit if necessary. C. W. HIGGINS.

One of the large manufacturers of electrical apparatus has on the market a well-nigh perfect automatic regulator for 60-cycle systems. GEO. B. LAUDER.

We obtained fairly satisfactory regulation on alternating-current, 60-cycle distribution system by means of hand regulation.
UNITED ELEC. LT. CO.

Satisfactory regulation can be obtained by hand regulators if the attendant knows the characteristics of his load and watches the load carefully. H. S. RUSSELL.

Satisfactory regulation can be obtained with hand regulators on a lighting load if the attendant watches the load carefully.
J. F. DOSTAL.

M 11. Is the feeder-pressure regulator a desirable auxiliary for the small central station?

No; not so much so as a voltmeter compensator.
W. H. GREENSLIT.

A feeder-pressure regulator is not only a desirable auxiliary, but it is an absolute necessity under certain conditions and is the best thing for the purpose of regulating the pressure for long feeders. C. W. KOINER.

Yes. J. F. DOSTAL.

Yes. F. C. S., MALDEN ELEC. CO.

Yes. A. E. WALDEN.

Yes, if more than one centre of distribution is required.
W. H. C.

Yes. GEO. W. RICHARDSON.

Yes; for alternating-current stations. HARRY M. HOPE.

Yes. G. H. CUSHMAN.

The feeder-pressure regulator is certainly desirable, even for small stations, and especially so, if the company furnishes free lamp renewals. CHAS. H. PETERS.

Yes. Good regulation is always very desirable.
F. ELLWOOD SMITH.

They are indispensable if good lighting service is to be maintained.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

M 12. What is the advantage of taking hourly readings on all feeder circuits? Does their value justify the use of an extra man or helper for this purpose?

(a) If alternating-current it may help to determine power factor on circuits by checking ammeter readings against wattmeter readings from time to time.
(b) No. W. H. GREENSLIT.

This is good information to have at times for future reference, but does not justify the use of an extra man for this purpose.
F. C. S., MALDEN ELEC. CO.

The taking of hourly readings on feeder circuits is not of much value for ordinary plants. A plant of ordinary size (such as may be found in cities of from 15,000 to 50,000 inhabitants) should have integrating wattmeters on each feeder or group of feeders, which should be read daily and the readings preserved. The monthly records of these meters afford a check against undue losses and theft of current between the switchboard and the customer. For the purpose of determining the form of the load curve, as an indication of the way in which the business is developing, it is worth while making readings of instruments every fifteen minutes, once or twice a month during the year, but an inspector can take care of this. DUGALD C. JACKSON.

Yes, except in very small plants.
THE COLORADO SPRINGS ELEC. CO.

These readings are valuable, but not at the price of an extra man to obtain them.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Hourly readings of all feeders provide record of each day's operation and require that the attendant watch his board. If the plant is large enough an extra man would be justified for this purpose, but the man in authority at the board should take the readings. AUGUSTA RY. AND ELEC. CO.

There are many reasons why hourly, or half-hourly, readings should be taken on all feeder circuits. Some of the reasons are:

(a) The maximum reading keeps you posted as to whether or not your copper is large enough for the load it carries, and whether or not some of the load could not be advantageously placed on another circuit having the same size copper.

(b) The minimum reading gives you a line on your losses in circuits, transformers, and meters. E. F. MCCABE.

Hourly readings are not necessary in all cases, but are valuable and in large plants necessary in showing the increase from year to year, and thus important in making estimates of future needs. It would hardly be wise to employ an extra man for this alone, but the records should be kept in some way, for the winter months at least. C. W. HIGGINS.

One advantage is that such readings add to the completeness of station records, and some time or other may be of incalculable value. Another advantage is that it insures more complete patrol and inspection by the attendants, as they must visit the feeder panels at least once an hour. It would seem that such hourly readings would hardly require an extra man, although circumstances alter cases. My judgment is that such readings are liable to be of great value as matters of record.

GEO. B. LAUDER.

The data obtained by readings on all circuits at intervals—say ten-minute intervals—are most valuable for plotting of load curves and subsequently noting load conditions of individual circuits. Such records have also good moral effect on attendants and result in better regulation and more careful attention to operation. The work required can be done by switchboard attendant without extra help, and is of material advantage in many ways. G. WILBUR HUBLEY.

M 13. How often is it advisable to test switchboard instruments?

About once every twelve months. A. PETERS.

Once every four months. F. C. S., MALDEN ELEC. CO.

Six to twelve months. C. W. KOINER.

We find that twice a year is often enough unless they have been subject to short-circuit or heavy overload.

HARRY M. HOPE.

Once in six months or a year—depending on instruments and use, also amount of vibration to which they are subject.

C. W. Higgins.

At least twice a year. David W. Beaman.

Switchboard instruments should be checked at least twice annually, probably spring and fall. G. Wilbur Hubley.

This depends on the class of instrument and the importance of its indications. Direct-current, integrating watt-hour meters, having a silver commutator, are the most subject to change. We find it pays to check the 500-volt wattmeters weekly, using the regular switchboard ammeter and voltmeter as standards. Direct-current lighting regulating voltmeters should also be checked weekly because of the far-reaching effects of an error in them. Ammeters are the least liable to change. It is sufficient to note monthly whether zero has shifted due to accumulation of dust on moving parts or weakening of spring. A shunt-drop check should be made once in three or four months to detect broken strands in shunt leads, *et cætera.*

Alternating-current instruments in general are less liable to changes than direct-current. We have found the horizontal edgewise type very satisfactory in this respect; even short-circuits on feeders do not throw them out of calibration. For the first few months after being put in use the pointer will gradually settle back of the zero, but this is easily adjusted and will require very little attention thereafter. Integrating wattmeters are very constant under normal conditions. If after lightning or a very heavy short an error is noticed, the ratio of transformation of current transformer should be checked, as well as meter itself.

G. R. Radley.

Every year. Fred B. Sharpe.

No general rule can be laid down. Whenever the instrument itself or any of its connections or any nearby conductors carrying heavy currents are changed, the instrument should be rechecked. In any case, it is inadvisable to allow too long a time to elapse between tests of instruments, particularly those on the accuracy of which the proper operation of the station depends.

ELECTRICAL TESTING LABORATORIES.

Every thirty days. This depends on the make of the instrument.

UNITED ELEC. LT. CO.

At least once a year.

E. F. McCABE.

At least once a year.

AUGUSTA RY. AND ELEC. CO.

The instruments on which the station economies are based should be tested once a month. All other instruments should be checked at least twice a year. Recording wattmeters running on sapphire jewels should be inspected and checked at the expiration of every 500,000 revolutions.

C. R. BROWN.

M 14. What is the most accurate way to check up alternating-current switchboard instruments when they are used in connection with current and potential transformers?

Switchboard instruments are more easily and accurately checked up by removing them from the board and checking them against instruments of known accuracy; where considerable refinement is required they should be checked against standards on alternating currents, but the standards themselves should be accurate either on direct or alternating current so that they (the standards) may be checked up on direct current against absolute standards of current and e. m. f.

For example, an alternating-current voltmeter of any type could be checked against a Weston voltmeter of moving-coil type, which is accurate on either direct or alternating currents, and this standard Weston voltmeter could be maintained accurate against absolute standards. The ratio of current and potential transformers, however, should be known under their working conditions. The current transformer may or may not have an exact ratio, depending upon the characteristics of the winding of the ampere-meter that is connected with it, and its ratio in connection with this ampere-meter should be determined.

E. W. GOUGH.

We use a 0-10-ampere Thomson portable inclined-coil ammeter with small portable water rheostat and lamp bank. As all pressure and current wires run to terminal boards located back of instrument panels, the test instrument is connected to instruments to be checked without disturbing instrument wires. Instruments are checked over entire scale by varying the load on them with rheostat and lamp bank.

For testing station voltmeters a Weston portable voltmeter is used. HARRY M. HOPE.

Means should be provided for the insertion of temporary standardized instruments and transformers in series with each group of switchboard instruments. This not only provides means for checking the permanent instruments and transformers, but also the connections, which are liable to be erroneous or to have become unintentionally deranged. C. R. BROWN.

The following method we find to be a rapid and sufficiently accurate method of checking our switchboard instruments. We short-circuit the secondary coil of our current transformer and then cut a standard ammeter and indicating wattmeter in series with the switchboard ammeter and indicating wattmeter, tapping the potential circuits of the wattmeters across the same points and arranging the connection so that no instrument indicates the losses in any other; then by means of a variable non-inductive resistance (*viz.*: a lamp bank) we vary the current flowing through the current coils of the instruments and compare the readings; if they check up, this completes the test; if not, the instruments are removed from the board and adjusted in the meter department.

By a slight modification this test can be arranged to check up the ratios of the current and potential transformers if desired.

S. R. INCH.

Removal and testing in laboratory.

AUGUSTA RY. AND ELEC. CO.

Alternating-current switchboard instruments used in connection with transformers can best be checked by testing them in connection with their transformers. This is not always feasible, since instruments using transformers are generally connected to high-tension conductors. For example, a wattmeter on a high-tension circuit can be checked by putting a standard wattmeter into the circuit with its voltage coil directly on the high-tension side of the potential transformer and a large amount of non-inductive resistance in series with it. It is much simpler to connect the series coils on the secondary of the current transformer for making a check of the instrument in position. The ratio of transformation of the current transformer must, in this case, be determined by a separate experiment in the laboratory after disconnecting the transformer from the high-tension circuit. It is perfectly feasible to determine, also, the ratio of transformation of the potential transformer in the laboratory. If this is done, the indicating instrument alone may be given a separate laboratory check. To determine the ratio of transformation of the current transformer, an accurate alternating-current ammeter, such as, for example, a Kelvin balance, can be used to measure the current on the primary side, while another ammeter measures the current on the secondary side. The way in which a check of this kind is made will depend largely upon local conditions, so that no general rule can be followed. Obviously, it is necessary in making checks on the instruments on the high-tension circuits to insulate thoroughly all instruments and multipliers employed.

ELECTRICAL TESTING LABORATORIES.

With voltmeter and dynamometers on primary.

G. WILBUR HUBLEY.

This question presumably refers to alternating-current switchboard-type ammeters, voltmeters and wattmeters, as these are practically the only instruments used in connection with current and potential transformers.

In the case of ammeters it can be assumed that the exact ratio of the series transformer is known, as this is usually stated by the maker of the instrument, and assuming this ratio correct, it is satisfactory to check the ammeter without the series transformer on a range of current in the same proportion to the actual current measured when instrument is in use, as the ratio of the transformer. Thus, if the ammeter with transformer is of 100 amperes capacity, the transformer would usually have a ratio of

20 to 1. The ammeter would therefore be of five amperes capacity and should be checked against any standard primary ammeter and should read exactly five amperes with five amperes on the standard instrument.

Any of the methods of checking ammeters as given in the answers to question M 15, is suitable for this purpose.

In the same way in checking a voltmeter, used with potential transformer, the ratio of the transformer is usually known, and this being the case the voltmeter can be checked on any secondary circuit of the same voltage as that for which the secondary of the transformer is adapted. This is an entirely satisfactory method and there are a number of ways of checking the voltmeter for the ordinary pressure for which the secondary of the potential transformer is made, 50 or 100 volts.

In checking integrating wattmeters or indicating wattmeters used with current or potential transformers, or both, a combination of the above method applies, and in case a wattmeter is being checked which is used in connection with the two transformers, it can be suitably checked on a circuit of the pressure and current capacity, as described for checking ammeter and voltmeter.

R. C. LANPHIER.

M 15. Which is the best transformer instrument for use in standardizing alternating-current ammeters—a Kelvin balance, a current dynamometer or a hot-wire ammeter?

A good current dynamometer whose accuracy is known, and whose accuracy can be checked up from time to time, will be amply sufficient to check up ampere-meters on alternating currents.

E. W. GOUGH.

The Kelvin balance, while it has certain disadvantages that are inherent in it, is undoubtedly the most reliable instrument for use in standardizing alternating-current ammeters. Some of the largest sizes of Kelvin balances are, however, affected by an eddy-current error which varies with the frequency. Such instruments should be avoided unless the necessary corrections are known. The current electrodynamometer, if properly constructed, is also a reliable transfer instrument. A hot-wire ammeter can be used only by taking great precautions to get the alternating and direct-current conditions exactly alike and to make the alternating current check at once, after the direct-current standardization has been made. ELECTRICAL TESTING LABORATORIES.

Kelvin balance. G. WILBUR HUBLEY.

The standardization of alternating-current ammeters is a trifle more difficult matter than standardizing direct-current ammeters, and of the method suggested in the question a current dynamometer or hot-wire ammeter is probably to be preferred to the Kelvin balance for the average central-station work. A Kelvin balance, to get best results, requires considerable experience and skill on the part of the operator, and is really a laboratory instrument of the first class. A current dynamometer is by all odds the most perfect apparatus known for measuring alternating current if the instrument is kept in proper condition and used with a correct calibration curve. Some dynamometers are calibrated on the dial to read in amperes, but the finer ones of these instruments usually have to be used with a curve.

A hot-wire ammeter is equally satisfactory, provided it has been carefully standardized by some reliable laboratory, and if it is not used too much for ordinary work. The advantage of the hot-wire ammeter is that it can be used with shunts for different ranges in amperes, whereas the dynamometer can not be, and for different ranges it is necessary to have either several dynamometers or different sets of coils in the same instrument. The preference of the writer—personally—for a transfer instrument in standardizing alternating-current ammeters—is a hot-wire ammeter, with proviso mentioned, that it shall be kept in good condition, and occasionally standardized carefully by one of the recognized laboratories. R. C. LANPHIER.

For all-around work when a number of readings have to be made in a minimum time and with an unsteady load, the current dynamometer is the most satisfactory. But if time is no object all three instruments give equally good results.

C. R. BROWN.

M 16. What is the best instrument and method to use in standardizing alternating-current voltmeters?

Hot-wire instruments. W. H. GREENSLIT.

A Weston voltmeter of moving-coil type, accurate on either direct or alternating currents. E. W. GOUGH.

Weston alternating voltmeter.
AUGUSTA RY. AND ELEC. CO.

An alternating-current voltmeter can probably best be standardized by comparison with a standard direct-current voltmeter or potentiometer, taking both direct and reversed readings. This method assumes that the voltmeter is free from error due to inductance, hysteresis, *et cætera.* An excellent way to standardize an alternating-current voltmeter with high accuracy is to use an electrostatic voltmeter of suitable range, as a transfer instrument. The electrostatic is calibrated on direct current by direct and reversed readings, and is thrown over to alternating current by means of a quick throw switch, so that its needle is not allowed to return to zero. This method of transfer is capable of great refinement if the alternating-current pressure is very steady. The instrument may then be read by means of a telescope and scale. This method is in daily use in the Electrical Testing Laboratories for the accurate determination of alternating-current pressures. ELECTRICAL TESTING LABORATORIES.

In standardizing alternating-current voltmeters for general purposes, the writer has found the most satisfactory method to be the use of dynamometer-type Weston voltmeter, which is kept for this purpose and which was first carefully standardized at the National Bureau in Washington, and at the Electrical Testing Laboratories in New York, a curve being made, giving the comparative readings on alternating and direct current at several points.

These Weston instruments have very little inductive error on alternating current for different frequencies, and there likewise is very little error in the readings between alternating and direct current, with the understanding of course that reversal readings shall be taken in each case, on direct current. The Weston instrument in practice is carefully checked from time to time against a standard potentiometer, and as the scale correction between direct and alternating current has been carefully determined once for all, it is then very easy to check any alternating voltmeters against the Weston standard by simply taking comparative readings. Of course, if a station is justified in having one, an electrostatic voltmeter is absolutely the best transfer instrument for direct current and alternating current, but this class of instruments is expensive and entirely unnecessary for most work, as good results to an accuracy of one-fourth of one per cent can be obtained by the method given above.

We may add that in checking the voltmeter against the potentiometer a set of storage cells is used so as to get very steady pressure for this checking. R. C. LANPHIER.

Standard Weston voltmeter. G. WILBUR HUBLEY.

M 17. What is the best method for determining the work constant of a watt dynamometer?

If the electrodynamometer is properly constructed, so that it is free from error due to inductance, capacity and eddy currents, its constant can be determined by direct-current standardization. If the electrodynamometer does not fulfill these conditions, its constant can be determined by comparing it on alternating current of the required frequency with a standard wattmeter that does fulfill the above conditions.

ELECTRICAL TESTING LABORATORIES.

Calibrate as a direct-current meter in the following manner: level up instrument on a stand that can be swung through an angle of 180 degrees; apply direct-current pressure to the pressure coil of dynamometer with no current flowing through the current coil. If meter is affected by stray fields dynamometer will swing; rotate dynamometer on stand until no deflection is obtained. Meter is then in position where it is not affected by external fields and can be accurately calibrated by using direct-current voltmeter and ammeter. G. N. EASTMAN.

M 18. Which will mean more to the station attendant—an ammeter upon the generator panel on the 3-phase feeder panel or an indicating wattmeter?

On a non-inductive load, an ammeter; on an inductive load, an indicating power-factor meter additional.

GEO. W. RICHARDSON.

Ammeters would be most necessary, showing the current limit, likewise the heating limit, of the generator to the attendant.

A. E. WALDEN.

Ammeter. F. C. S., MALDEN ELEC. CO.

Generator panel should have both; ammeter for balancing and indicating wattmeter for total readings.

H. M. BEUGLER.

An ammeter on each leg of a three-phase feeder panel will mean more to a station attendant than will an indicating wattmeter. H. N. CRANDALL.

The indicating wattmeter would be of more value to the attendant than would an ammeter. A. R. MACKINNON.

Ampere-meters measuring the actual current load upon a generator are of more importance than an indicating wattmeter, in that it shows to the attendant the amount of current flowing, and, consequently, the amount of heating which the machine may be expected to be undergoing; whereas the wattmeter, while it will show him the output of the machine, will not give him, unless other instruments are consulted, the actual current flowing, provided the power factor of the circuit is less than 100 per cent. By the use of a wattmeter and voltmeter and no other instruments, he is unable to tell how heavily his machine is loaded.

E. W. GOUGH.

Indicating wattmeters on generator and totaling panels, ammeters on feeder panels. HARRY M. HOPE.

Where three-phase generators are run in parallel, indicating three-phase wattmeters ought to be mounted on each generator panel. Ampere-meters alone do not enable the attendant to tell whether or not the machines are suitably dividing the external load and are not burdening each other with excessive cross-currents. It is also desirable to have an ampere-meter or ampere-meters on the generator panels for the purpose of determining whether or not the generators are working harmoniously together. It is desirable to have ampere-meters and integrating wattmeters on the feeder panels. In connection with this see the answer to question M 12. DUGALD C. JACKSON.

Use both. G. H. CUSHMAN.

Indicating wattmeter. J. F. DOSTAL.

The indicating wattmeter means more to the station attendant than does the ammeter, for he can read the load at a glance. The ammeters across the phases are of greater benefit to the superintendent or engineer in charge in determining how well the loads on the different phases are balanced. SAM'L KAHN.

An ammeter should indicate more in either case to the attendant, as amperes per phase is easier to remember than watts per phase; though in case of a wattmeter its speed will indicate a good field adjustment. C. W. HIGGINS.

An ammeter is essential on a generator or underground feeder, in order that the attendant may limit the current to the safe carrying capacity of the armature or underground cables. If the load is not strictly incandescent lighting, a wattmeter is necessary if it is important to know the actual useful load being carried. THE SEATTLE ELEC. CO.

The ammeter will generally be the more useful if the load is nearly balanced. M. P. R., N. Y. ED. CO.

Indicating wattmeters. F. ELLWOOD SMITH.

The indicating wattmeter on a standard system furnishes the station attendant with the most reliable information, as it reduces largely the amount of figuring necessary to obtain actual loads.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Since it is amperes that cause most of the heating in an armature and are more of an indication of the danger point than are kilowatts, on account of varying power factors, an ammeter would seem preferable; although for records, the kilowatt-output is frequently more valuable. On one of our feeders we have 110 amperes with about 250 kilowatts, and later, on the same panel, we have 70 amperes with nearly 350 kilowatts, the power factor varying from 75 per cent to nearly 100 per cent. We have both ammeters and indicating wattmeters on our feeder panels, and ammeters only on our generator panels. GEO. B. LAUDER.

An indicating wattmeter. H. S. RUSSELL.

An ammeter. The ordinary station attendant knows a great deal more about amperes than he does about watts, unless he has been very especially trained to wattmeters. C. F. HAYWOOD.

Ammeter. G. WILBUR HUBLEY.

M 19. Are separate current transformers necessary for the ammeter and for the time-limit relay on alternating-current feeders, or can both instruments be operated satisfactorily from one transformer?

The writer has charge of a plant in which a polyphase recording wattmeter, three ammeters, and an overload relay, all receive current from one set of two current transformers connected to produce a resultant delta and operate with entire satisfaction. L. O. VESER.

Both can be operated from one transformer.

HARRY M. HOPE.

If the proper constants are chosen for current transformers, ammeters and time-limit relays, but one current transformer is necessary to operate an ammeter and a time-limit relay, it being possible if desired to add two or three more instruments to the circuit without affecting the accuracy of the readings if the current transformer is properly chosen in the first place.

H. H. BARNES, JR.

Separate current transformers are not necessary.

M. P. R., N. Y. ED. CO.

As to whether separate current transformers are necessary for ammeters and time-limit relay on alternating-current feeder circuits, the matter depends both on the capacity of the current transformers and upon the relays. If the relays have such a high resistance that there is not enough pressure in the series transformer circuit to operate them without an excessive drop in voltage, or if the relays are designed with a variable magnetic induction, the ammeters would not read correctly with the relays in the same circuit. BERTRAND ROWE.

The same current transformer will do for both ammeter and time-limit relays on alternating-current feeders.

H. J. MEYER.

M 20. (a) What is considered the best design for ground plates? (b) What is regarded as the best practice in locating same, and their connection to the different generators, transformers and instruments in stations or substations? (c) Should all this apparatus be connected to the same ground 'bus, or should there be an independent ground 'bus for each class of apparatus?

Flat sheet copper. For protection from lightning, all runs should be as nearly as possible in a straight line to earth.

RALPH D. LAXTON.

(a) The best ground for high-tension apparatus can be made by attaching to underground water mains.

(b) For a station ground plate the best practice is to sink a tinned copper plate in permanently damp earth and embed it in crushed coke or charcoal, preferably pea size. In a water-power station, connection should also be made to the iron flume.

(c) The best practice is to connect all ground circuits and the frame of the building, as well as all apparatus to be grounded to the same circuit. BERTRAND ROWE.

A one-inch galvanized-iron pipe, eight feet long, driven in the ground, shows results on the lightning arrester. All parts should be insulated for safe protection.

AUGUSTA RY. AND ELEC. CO.

M 21. Should the discharge resistance leads for any generator field switch be insulated for a higher pressure than the field leads?

No. BERTRAND ROWE.

There does not appear to be any reason for insulating the discharge resistance leads of a generator field switch with greater care than the main field leads themselves.

H. H. BARNES, JR.

No. Both sets of leads are subjected to the same insulation strain. M. P. R., N. Y. ED. CO.

No. The pressure is the same throughout the field leads as in the discharge resistance leads. CLAYTON GEIGER.

M 22. Has any form of 3-phase reverse-current relay for use on the substation ends of high-tension feeders in multiple, proved satisfactory in service?

A reverse-current relay which depended on pressure and current was installed for test. It proved a failure because the drop in pressure at time of reversal of power made the device inoperative. EDW. SCHILDHAUER.

M 23. (a) How often is it usual to change the oil in oil switches of 15,000 volts, 100 to 300 amperes capacity, when oper-

ated once or twice daily? (b) How can one tell when change should be made?

If switches are opening large quantities of current once or twice daily, the oil should be changed at least monthly, but if they are opening only small amounts, once in six months or even once a year would be good practice. In general, however, after a switch has opened 5000 to 10,000 kilowatts under short-circuit conditions it should be inspected and the condition of the oil should govern a decision as to the need of changing the oil.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

A moisture test is properly sufficient to determine when oil should be changed. A sample of oil should be taken from switch, and heated in a vessel covered with a glass plate, raising to temperature of boiling water. If a perceptible amount of water condenses on the glass cover, oil should be changed.

G. N. EASTMAN.

M 24. In determining the correctness of recording wattmeters, is it necessary to check the ratio of series and shunt transformers from time to time, when such apparatus is used on wattmeters?

The ratios of series and shunt transformers that are used with electrical instruments ought to remain unchanged unless the transformer has been damaged. If any accident has occurred to a transformer or there is reason to believe that some of its turns may have become burned out, it is then desirable to check the ratio for the purpose of learning whether or not the transformer is still in satisfactory condition. DUGALD C. JACKSON.

If series and shunt transformers furnished with integrating wattmeters have been properly constructed by the manufacturer, as most of these devices are at the present time, there is no reason why there should be any necessity of checking the ratio of either the series or shunt transformers after this ratio has once been determined and given, unless the transformers are damaged at some time so that they have to be rewound. In this case it is, of course, best to determine the ratio exactly before installing again with the instruments for which the transformers are made.

R. C. LANPHIER.

With well-designed series transformers the change in the ratio due to aging is usually negligible and does not affect the wattmeter readings. The effect of age on the shunt transformers will not affect its ratio. BERTRAND ROWE.

It is wiser to do this each year when the instruments are tested. AUGUSTA RY. AND ELEC. CO.

N

BELTS AND SHAFTING

N 1. Are rubber belts for high speed on generators better than leather? Why?

Sometimes, yes—sometimes, no! High speed may mean rapid run in lineal feet per minute, or high speed in revolutions of driver and driven pulleys. Therefore, if pulleys are small in diameter and of high rotative speed, rubber belt, owing to its flexibility, is preferable to leather. Otherwise, no. Rubber belts when employed should be the very best in material and workmanship, of suitable ply for strength, and of ample width to transmit the required quantum of power. E. T. COPELAND.

Leather belts are the best for ordinary work, for the reason that they give better satisfaction all around, as to wear, tear, *et cætera.* C. W. KOINER.

No. They wear out too quickly. J. F. DOSTAL.

No.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

The red-strip, non-stretchable rubber belts are better than leather, because when you once get the right tension they will become no tighter, and they are less liable to slip. If slipping does occur a slight dressing of boiled linseed oil will stop it at once. W. P. CAHILL.

Rubber belts are not desirable on high or low-speed generators, for the reason that wire fastening or lacing is not so strong nor so smooth as the scarfed and cemented joint; moreover, if any oil falls on a rubber belt, the rubber is rapidly dissolved, making a sticky mess. CHAS. H. PETERS.

Double leather belts are preferable.

G. WILBUR HUBLEY.

N 2. What per cent of power is wasted in a good belt driving a generator as compared with a direct-connected unit?

Four per cent. C. W. KOINER.

Have made several tests in this direction and have found very little in favor of the direct-connected unit, the percentage of friction of belt-driven being below that of the direct-connected unit. THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

In some cases not over 0.5 per cent; in others, three to seven per cent. GEO. W. RICHARDSON.

Approximately 10 per cent. G. WILBUR HUBLEY.

N 3. In calculating length of belt, when same must be cut and cemented before putting on, how allow for stretch?

One-eighth inch for each foot in length of belt.

CHAS. N. SHAW.

A very simple method is to measure or calculate the length of the belt very accurately and deduct one-eighth of an inch per foot for single belt, and one-sixteenth of an inch per foot for double belt; this makes a belt about as tight as it can be put on pulleys. J. F. C.

Never mind about the stretch; allow for getting it on.

GEO. W. RICHARDSON.

The best plan is to put the belt around the pulleys and pull up the belt-stretcher before making joint, as no calculation can be made for the amount the belt will stretch.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

New leather belts stretch from one-fourth to one-half inch per foot, and must be taken up accordingly. W. P. CAHILL.

Allowance for stretch in leather belt depends on its length and thickness. If no means are provided for taking up the stretch on belt, the best you can do is to give supply house the exact measurement over pulleys, and they will take stretch into consideration as far as possible. All new belts, however, keep stretching from time to time, and if it is impossible to remove from pulleys, belt clamps will be necessary to take up slack while resplicing. CHAS. H. PETERS.

N 4. What is a safe rule for size of shafting for direct-connecting dynamo and water-wheel shaft?

For shafting of turned iron, bearings eight feet apart.

$D =$ diameter of shaft in inches
$R =$ revolutions per minute
$H =$ horse-power

Then

$$D = \sqrt{\frac{125\,H}{R}}$$

This formula is the minimum diameter, therefore judgment must be used in selecting a size larger than that given in formula, depending on the distance apart of bearings.

GEO. W. RICHARDSON.

The shearing strength of steel is equal to three-fifths of the tensile strength. Assuming the ultimate tensile strength of machine steel used in shafting at 85,000 to 90,000 pounds per square inch, the ultimate shearing strength would be about 52,000 pounds per square inch, or a safe working stress, on a factor of safety of 4, about 13,000 pounds per square inch.

The turning moment of the shaft in inch-pounds, divided by the cross section of the shaft in square inches should be not over 13,000.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

N 5. Which is the most efficient pulley, leather-covered, wood or paper?

From some considerable experience with pulleys of varied characteristics, I find that paper pulleys of reasonable sizes give the best service. LEE BOYER.

We prefer paper pulleys. F. L. WILLIAMSON & CO.

Wood, for small pulleys, at least. FRED H. BECK.

Leather-covered pulleys are naturally the most efficient, but wood can be more securely placed on a pulley where the size is to be increased. It is very hard to make leather hold on an iron pulley. My experience with paper pulleys is that they get very slippery and cause a great deal of trouble, and when an effort is made to stop the slipping they have a tendency to cake very badly. For electric-light work where iron pulleys can be used I would recommend the use of slack belts and the preparation known as cling surface; it has proven very satisfactory to us.

FRED M. LEGE, JR.

I consider a perfectly smooth iron pulley most efficient.

D. O'CONNELL.

Very little choice, so far as I can see, in actual practice, but we make a practice of specifying paper pulleys in all contracts for generators, having had excellent success with them.

E. W. FURBUSH.

O

OIL AND WASTE

O 1. What make of oil is best for lubricating cylinders using superheated steam?

O 2. What fire test should cylinder oil stand for use with 90-pound steam; also 125-pound? Speed 100, cylinder 20 by 42?

Six hundred degrees Fahrenheit. C. W. KOINER.

Six hundred to 650 degrees fire test. CHAS. H. PETERS.

O 3. What are the effects of superheated steam on cylinder lubrication, with 150 pounds pressure; steam superheated to 100 degrees or more?

We have to use some 40 per cent more cylinder oil with superheated steam than with wet steam. W. P. HANCOCK.

O 4. Does the most economical cylinder oil have very little or no animal fat?

The high-grade cylinder oils are mineral oils.
C. W. KOINER.

The best cylinder oils contain some animal fats.
O. H. YOUNG.

After frequent tests we find that most economical cylinder oil has very little, if any, animal fat.
MADISON LT. AND RY. CO.

The best and most economical cylinder oil contains no animal fat. CHAS. H. PETERS.

All good cylinder oils have a small percentage of animal fat.
G. WILBUR HUBLEY.

A very little animal fat is very desirable in cylinder lubrication unless the condensed steam is to be returned to the boilers, in which case its deleterious effect upon the feed water would more than offset its lubricating advantages.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

I believe that the oil manufacturers, in compounding cylinder oil to make a high-priced and high-test oil, put in more tallow than in the cheap grades. W. H. MILLS.

O 5. Describe some convenient and cheap apparatus for removing oil from used waste and making it suitable for further use.

It has been found well to squeeze the oil from the waste with a press. In this way considerable oil can be taken from the oil-filled waste. C. W. KOINER.

Centrifugal wringer with a little steam will extract the oil.

G. H. CUSHMAN.

Machine made for this purpose by Oil and Waste Saving Machine Company, of Rochester, N. Y., is most convenient, and is efficient and economical for operation, although first cost is high. G. WILBUR HUBLEY.

Take a piece of 12-inch steam pipe about 18 inches long, and secure a cap at the bottom. Perforate the bottom. Inside of this place a plunger that can be screwed up and down by a screw passing through a yoke fastened to the top of the 12-inch pipe. Oily waste can be placed in this pipe, and when the plunger is screwed down the oil will be squeezed out from the waste and can then be filtered and used again; the waste can be washed and used again. F. ELLWOOD SMITH.

We have used for this purpose for ten years with eminent satisfaction, the Economy waste press, made by the Strong Machine and Supply Company, of 2½ Murray street, New York THE EDISON ELEC. ILL'G CO. OF BROCKTON.

A piece of eight-inch pipe combined with the use of a screw from an old jack-screw can be made up into a good oil press.
AUGUSTA RY. AND ELEC. CO.

O 6. What is the length of time one filling of an oiling system can be used where the oil is pumped back into the tank and used over again? Does not the oil gradually wear out?

There is always some waste of the oil, and by replenishing same the viscosity of the oil is maintained.
GEO. W. RICHARDSON.

We use oil over and over again, adding new oil as need requires. DAVID W. BEAMAN.

Depends on grade of oil used, the efficiency of the filters, the amount of make-up supply required, and so forth.
G. WILBUR HUBLEY.

Six months to a year, according to the amount of oil in tank.
AUGUSTA RY. AND ELEC. CO.

O 7. If the temperature of oil is 160 degrees Fahrenheit when it comes from the turbine step bearing, is it necessary to cool before using again?

I find that the oil gives better results if not cooled; that seven gallons of oil per month will lubricate the step-bearings of two 500-kw turbines. THOMAS HAWKEN.

The temperature of the oil entering the bearing must be the best guide in this matter. If large tank and radiating surface cool the oil so that the temperature of the oil leaving the bearing never rises above 160 degrees, cooling may not be necessary.

Have seen a case where oil was not cooled for seven hours and in that time the temperature had steadily but very slowly risen to about 180 degrees. The tank capacity and radiating surface in this case was quite large. Normal temperature of oil leaving bearing was about 120 degrees.
THE PHILADELPHIA ELEC. CO.

O 8. What is a good lubricant for wooden cog gears meshing with steel pinions?

Molasses and graphite. CHAS. N. SHAW.

Albany grease—sometimes called hard oil.
GEO. W. RICHARDSON.

The Standard Oil Company makes a special grease for this purpose, which gives splendid results. P. H. KORST.

Hard grease and powdered graphite mixed.
A. R. MACKINNON.

I have until recently thought we *must* use Albany grease, but having a shipment delayed used lard compound as a makeshift and found that it answered perfectly at about one-third the cost.
E. W. CROCKER.

Very fine sawdust, graphite and grease.
AUGUSTA RY. AND ELEC. CO.

A good lubricant for wood cog gears meshing with steel pinions is composed of one and a half pounds flake graphite mixed with ten pounds of Albany grease. Melt the grease and mix the graphite with same and apply with a brush when gears are running slow. H. P. WOODS.

Tallow and graphite have given us good results for the last six years Melt the tallow, mix with it some flaked graphite, and apply to the gear wheel with a paint brush while the gear is running. LEE JERNIGAN.

O 9. If a cylinder oil leaves a sticky, brownish substance on valve seat when the valve has cooled off by exposing to the air, does it show over-compounding, or compounding to give viscosity regardless of lubrication?

The best cylinder oil of the compounded stock contains 95 to 97 per cent steam-refined mineral oil and three to five per cent of acidless tallow oil; the oil to be compounded at a temperature not less than 300 degrees Fahrenheit, the mineral stock to be 25.5 to 26 degrees Baume gravity, 580 flash and 640 fire test, to be dark filtered but not a black oil.

It is desirable, however, to keep the percentage of animal oil as low as possible, as a large quantity of it will leave a gummy coke deposit in the cylinder, which will seriously attack not only the joints but the iron itself. S. C. FOSTER.

P

OVERHEAD LINES

P 1. Has any one used crude oil or tar in the treatment of poles? If so, with what success? State method of application.

Have applied hot tar to season poles for several years and from present appearance the poles are preserved by this treatment.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

We are using the tar from our water-gas works to paint the butts of all our poles, and find that the horses will not touch them after we have the butt well tarred. G. B. LELAND.

Crude oil, yellow ochre and lamp-black make a good green, and will wear well. FRED B. SHARPE.

Have used tar on butts of poles, applied hot, and don't think it pays the expense of putting on. It preserves the outer shell and holds the dampness inside, causing it to decay sooner than it would otherwise do. If it could be forced in under pressure I think it would preserve the pole. HERBERT E. BRAGDON.

Tar was used on poles set in damp and swampy places and increased the life of the poles from two to four years over that of poles not tarred. To get the best results the poles should be charred for a distance of six or seven feet at the butt, and the tar thickly applied with a brush while poles are still warm.
A. M. COVER.

In regard to treatment of poles, we get tar from the gas company, thin it a little with kerosene and apply with a heavy brush about eight inches above the dirt line and about two feet below. H. E. RYDER.

P 2. Does creosoting from 7 to 8 feet of the base of cypress poles, where poles are set 5 feet, prolong the life of same long enough to justify the expense of creosoting?

Yes. W. H. GREENSLIT.

We have tried different methods of preserving wooden poles, and the method that has proved most successful—which I think should be brought to the attention of the electric-light companies—is a cement butt. This cement butt is six feet long where the butt is set five feet in the ground, and, by means of four galvanized-iron clamps set into the cement, you set the wooden pole on top of the cement butt. The galvanized clamps are brought up on the four sides of the poles directly opposite one another, and the two bolts are put through the clamps in the poles to hold the same, making a very substantial job. The top of the cement butt comes about one foot above the top of the ground, thereby preventing the rotting that takes place with wooden poles at the ground line, especially due to rain hitting the ground and splashing up against the base of the pole.

We have had some of these poles in use for two years and they have shown no perceptible wear, and we are setting all our new pole construction with these bases. When the wooden pole becomes defective, all that has to be done is to unscrew the bolts and set a new pole on the cement butt, thereby avoiding the trouble, on the city lines, of having to have your pole-hole locations relocated. D. H. Hegarty.

Creosoting a cypress pole at the base one foot above the ground line will make it last from twenty to twenty-five years.
H. J. Meyer.

I don't think so. Herbert E. Bragdon.

We have been painting with Carbolineum all poles we have set during the last few years, and believe the poles will last enough longer to pay for the trouble and expense of the treatment.
F. L. Williamson & Co.

Creosoting any wooden poles from the bottom to a point 12 inches above the ground line, is the best kind of investment a company can make. We find that three to four coats of C. A. Wood Preserver, which is a creosote preparation, increases the life of poles almost 75 per cent in our dry locality.
Chas. H. Peters.

P 3. In building a 2200-volt single-phase transmission line, how should the transposing poles be constructed?

Transposition is not necessary. W. W. TITZELL.

P 4. What is a good method of dead-ending heavy primary pole line feeders; something that will answer the purpose of the regular strain insulators?

A very good method is to use a number of high-strain insulators in series, using one to every 500 volts. If used in a horizontal plane they will give very good results. J. F. C.

By the regular guy-wire method, using enough strain insulators in series to stand the electrical strain and enough in parallel to stand the mechanical strain. W. H. GREENSLIT.

We have found success with double-arming, using good locust pins, and placing end of feeder so that the strain comes equally on the two pins; then bridle-guy each set of arms back to stub, having a good anchor. It is possible and safe to thus hold No. 00 wires. A. PETERS.

Have had very good success with strain insulators made by using large spool-shaped porcelain insulators clamped with bolts between two iron plates, tieing one insulator to the live wire and the other to the cross-arm. If very high voltage is used, two or more sets of spools can be used in series.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

One method would be the use of an insulated pole ratchet. Another method is the construction of a pin with a yoke—the yoke to fit over and be bolted to the arm. Special insulator of gutta-percha made fast to pin. F. J. ARNOLD.

A "break-arm" with triple-petticoat porcelain insulators makes a safe and permanent job. The feeder is attached to one insulator and the guy wire to the other. D. CLINTON SHAIN.

Double-arm, with bolts through each end of arms; end tie on outside glass. FRED B. SHARPE.

Double-arm last pole, anchor end of line on last glass and tie in on opposite glass. Double-arm next pole and tie in on each glass with proper gauge copper wire. Guy arms to stub, making guys fast to eye-bolt running through blocks between arms, setting strain-ball insulators in each guy near the arms and guy stub. W. W. TITZELL.

Use recently developed spool-shaped porcelain insulator, in which the wire is fastened about midway between two petticoats; a bolt passes through the insulator and through the cross-arms directly above and below same. WARREN PARTRIDGE.

P 5. With overhead wires, what is the voltage limit to be safely handled when lineman is on a wet pole?

Five hundred volts. W. H. GREENSLIT.

Two thousand volts would seem to be the limit, as we have some difficulty in handling that at times. W. L. SEES.

If gloves were dry, 2200 volts. D. CLINTON SHAIN.

Twenty-five hundred volts. G. H. CUSHMAN.

Pull the switch at station and then the lineman is safe if he handles every wire as though it were a 2200-volt circuit.
HERBERT E. BRAGDON.

Twenty-three hundred volts is as high as should be attempted, and then only when the lineman is properly equipped with suitable safety apparatus.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

With great care, and the use of rubber gloves and rubber boots a safe voltage limit would be about 4000 volts.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Four thousand volts to 5000 volts, if good rubber gloves are used. M. P. R., N. Y. ED. CO.

P 6. Suggest ways of removing static charge from arc and primary circuits, especially when partly overhead and partly underground.

Where wire and cables are lead-covered, grounding the sheath is a successful method of removing this static charge. H. J. MEYER.

Let the static discharge to ground through a heavy pencil mark on a strip of ground-glass. J. F. DOSTAL.

Gap lightning arresters. G. WILBUR HUBLEY.

Use lightning arresters or high-resistance static-discharge apparatus at the station ends of the circuits and also at points where circuits make underground connections. THE EDISON ELEC. ILL'G CO. OF BOSTON.

Ground the circuit. M. P. R., N. Y. ED. CO.

A small motor could easily be arranged with rotating arm and condenser to wipe the charge off the lines, while in operation. AUGUSTA RY. AND ELEC. CO.

P 7. (a) What, if any, is gained by using a grounded neutral on an Edison 3-wire, direct-current, 110-220-volt system? (b) What is the best method of grounding same, and how far apart should ground connections be placed?

(a) By grounding the neutral it is impossible to get a 220-volt short or 220-volt shock. At the same time, it is rather conducive to the destruction of meters, or seems to be so.

(b) Ground at station to a copper plate placed as if for lightning arresters and connect to ground out on line wherever convenient. A. PETERS.

Impossible to get over 110 volts between line and ground. Reducing the strain on fixture insulators, inside wiring, lamps, and other appliances, has numerous advantages.

D. Clinton Shain.

Follow the rules in National Code. G. H. Cushman.

(a) Reduces voltage to maximum of 110 volts. Not necessary to use insulated wire on neutral.

(b) Ground connection should be made at convenient points to underground pipe lines, or, wherever these are not available, by copper connection to ground plate buried at least six feet below surface of ground. G. Wilbur Hubley.

(a) The advantage of grounding the neutral wire of an Edison three-wire system is safety to customers from high potential entering their premises, due to crosses with high-voltage lines. The ground makes it impossible for greater potential than 110 volts to exist between either wire and the ground. (b) Rule 13A of the National Board of Fire Underwriters, 1903, requires grounding of three-wire systems every 500 feet. An excellent ground may be obtained by about two bushels of coke about the size of an egg buried five or six feet in the ground around a copper plate. This method has been very carefully discussed in a special bulletin of the New England Insurance Exchange, dated March 15, 1905, entitled *Grounding Low-Potential Circuits.*

The Edison Elec. Ill'g Co. of Brockton.

The principal advantage in grounding a neutral on a three-wire overhead system, is that danger to life due to crosses with series arc or other high-potential circuits is avoided. In a small town, where there are no high-potential wires, there would be no particular object in grounding the neutral of a 115-230-volt, direct-current system, except that there might be less liability to damage to property and apparatus from lightning storms.

W. G. Carlton.

(a) The neutral should be grounded:

First—To limit the potential strain between wire and fixture to approximately 110 volts.

Second—When a defect occurs in insulation it immediately becomes manifest by blowing of one fuse. This fuse, being on but a 110-volt short-circuit, opens without fail. With two fuses in series on a 220-volt short-circuit, the arc may hold.

Third—It is not possible to shunt the customer's meter, either accidentally or intentionally, by a ground after the meter and another one before it. With neutral purposely grounded these grounds on the outside wire either blow the service fuse, or, if partial, show up on the meter and will probably be discovered when a "kick" is made on the high bill.

(b) The proper place to make the ground is at the station, and there *only*. If other grounds are made the return current of street-railway system may enter by them and flow to station *via* the lightning neutral, causing an unbalancing at distant end of twice the amount of drop thus caused in neutral conductor. Ten volts per mile is frequently found on railway returns; this would unbalance the lighting system 20 volts. This has actually occurred.

G. R. Radley.

(b) If the neutral of an Edison system is grounded, the best method is to ground it at the station only. Especially so, if the lines parallel electric street-railway lines using the rail as part of their electrical circuit. In case of two or more grounds, the neutral will have a tendency to carry part of the railway current from one ground to the other. This current will vary as the load in the street-railway system varies, and is apt to cause a fluctuation of voltage on the lighting system. E. J. Bechtel.

Where the system is liable to be unbalanced, the drop has been lessened by grounding the neutral at the station and at the points where the unbalancing occurs. J. F. Dostal.

(a) Advantages are that the possible shock to consumer who handles fixtures is reduced to one-half the pressure of the system, that is, 110 volts. A well-grounded neutral system assists materially in balancing one district against another without relying on the neutrals in feeders carrying the unbalanced current back to the station to be balanced there.

(b) Ground stakes in every manhole and heavy ground plates at all stations sunk in damp soil provide all necessary ground capacity. Grounds should be made on system at least every 500 feet. THE EDISON ELEC. ILL'G CO. OF BOSTON.

P 8. What objections are there to grounding the neutral of a 4-wire 3-phase system outside the station and relying upon these ground wires on neutral instead of lightning arresters? This refers to systems operating with neutral grounded in station.

Grounding the neutral of the three-phase system permanently increases the danger in handling the high-tension lines, and, acting in place of the lightning arresters that would be normally placed on the phases, increases the risk of a discharge through some of the apparatus connected to the neutral; assuming, of course, that the three-phase wires are insulated from the ground. E. W. GOUGH.

If the grounds are made to a railway track direct current will flow over the alternating-current neutral and phase wires, and this may cause fictitious indications in series ammeters at the station—those not used with current transformers. Should "C. R." type of feeder regulators be in use on these feeders, this direct current may hold the arc from one clip to the next, short-circuiting a coil and burning the contacts. G. R. RADLEY.

When outer wires receive static charges they are relieved only by discharging through transformers or generators, endangering apparatus. The proper way is to install a series of gaps from each outer to common wire and ground common wire at each place where this is done. W. H. C.

After a system has been operated with neutral grounded in the station, it will be found to be grounded outside also, due to no attempt being made to keep it clear of grounds. Hence conditions will not be changed by intentionally grounding it outside. The advantages gained by grounding a neutral at each lightning-arrester installation are as follows:

Renders placing of arresters on a neutral unnecessary, thereby reducing arrester investment and maintenance cost.

Partial protection against gradual accumulation of high charge on phase wires, by allowing a path for discharge from phase wire through primary of transformer to grounded neutral. The ground on neutral should not be depended upon entirely as protection, but arrester should be placed on phase wires.

PAUL F. WILLIAMS.

We see no objection to grounding the neutral of a four-wire three-phase system at the station only, but if grounded at different points in a street-railway district, the return currents of a street railway are apt to be annoying. Lightning arresters should be used with this method. E. J. BECHTEL.

Grounds should not be relied upon as lightning arresters, because they would require that the discharge, in order to reach the ground, pass through some of the translating devices on the lines. There is no objection, however, to using some of the neutral grounds for the purpose of grounding lightning arresters on the outside wires.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

P 9. (a) Is it good policy to ground lightning arresters to street railway track, provided the tracks and water mains are bonded together at the power-house? (b) If this ground is not considered sufficient at a distance of two miles from the power-house, would there be any danger to the track or cars?

It is desirable to have independent ground from railway track, unless ground connection to same is in close proximity.

G. WILBUR HUBLEY.

The ground wire of lightning arresters can be very well grounded on the railway track with the best of results if the track is solid. But the liability of the wire becoming loosened must be taken into consideration.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

No. FRED B. SHARPE.

(a) I do not think it good policy.
(b) Do not think it would damage track or cars.

HERBERT E. BRAGDON.

The best policy is to ground lightning arresters both to the street-railway lines and to a separate ground.

E. J. BECHTEL.

We ground our lightning arresters to street-railway track, ground track into river and such permanently damp spots as are handy, and find this method perfectly satisfactory.

CHAS. H. PETERS.

This is good policy, and would not be at all dangerous.

M. P. R., N. Y. ED. CO.

We should call it good policy, and we see no possibility of damage to cars or track.

AUGUSTA RY. AND ELEC. CO.

P 10. Is there any successful method of protecting high-tension transmission lines from lightning? Where is it used?

Run a bare wire over the top of the conductor; usually a single line on top of the pole will be sufficient; barbed wire is particularly good.

E. W. GOUGH.

Efficient lightning arresters on line and choke-coil panels in station.

G. WILBUR HUBLEY.

P 11. Describe a good method of placing lightning arresters on a junction pole of a transmission line, where the aerial line joins underground cable?

It is preferable, owing to the presence of cables, cable joints and pipes on a cable pole, to place the lightning arresters on the first pole away from the cable pole. In this way a standard installation can be made in the same way that it is made anywhere else on the line and the protection of the cables is equally good.

H. B. GEAR.

Lightning arresters should not be placed on such a pole, but on the next pole to it. W. L. SEES.

Carry the underground cable up the pole to the required distance above the ground, fastening same to pole by lead clips. Install pothead on end of cable and attach overhead wires to terminals of cable in pothead. Protect pothead with a suitable house, which is proof against weather, using suitable porcelain bushings to bring wires to pothead through sides of house. This construction is excellent for pressures up to 15,000 volts and necessitates a house approximately two feet by one and one-half by one and one-half feet.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

It would be better to place the lightning arresters one pole away from the junction pole connecting with underground lines, in order to avoid too much apparatus on the junction pole.

W. G. CARLTON.

P 12. What is the smallest size weatherproof copper wire mechanically safe for overhead city line?

Number 10 B. & S. gauge. G. WILBUR HUBLEY.

Depends upon the length of the span; usually a No. 6 is about as small as is mechanically safe. E. W. GOUGH.

Number 6 B. & S. gauge. J. F. C.

W. H. GREENSLIT.

A. PETERS.

W. L. SEES.

F. C. S., MALDEN ELEC. CO.

J. W. CARTWRIGHT, JR.

A. R. MACKINNON.

FRED B. SHARPE.

PAUL F. WILLIAMS.

H. J. MEYER.

G. H. CUSHMAN.

E. J. BECHTEL.

CHAS. H. PETERS.

J. F. DOSTAL.

F. ELLWOOD SMITH.

H. E. RYDER.

H. BOTTOMLEY.

F. W. BULLOCK.

JOHN J. GAFFNEY.

Number 8 hard-drawn copper. G. B. LELAND.

About nine years ago we adopted No. 10 B. & S. weatherproof wire, as the smallest we would use on 1000-volt primary circuits. Since that time we have not had a wire down. Prior to that, we had two cases when No. 12 broke, killing a horse each time. P. E. COWLES.

Would use nothing smaller than No. 8 hard-drawn.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

Nothing smaller than No. 8 should be run as overhead conductor. C. W. KOINER.

Number 8 for spans up to 100 feet. Number 6 for spans over 100 feet. D. CLINTON SHAIN.

Size No. 8 B. & S. gauge is the smallest we think advisable.
THE COLORADO SPRINGS ELEC. CO.

Number 8 B. & S. gauge. HERBERT E. BRAGDON.

We never use wire smaller than No. 10 B. & S. gauge. On high-potential lines, wire smaller than No. 6 should not be used.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

It depends on the distance between supports, but for regular pole lines (poles 120 feet apart) No. 10 gives best service, as smaller sizes will not stand much sleet or fires. A. M. COVER.

Where stretches do not exceed 90 feet, No. 6 wire is safe, but above that distance No. 4 is as small as should be used to be considered safe.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Number 10 B. & S. gauge. S. R. INCH.

Number 6 is mechanically safe if no trees are encountered, and if bad trees are encountered nothing smaller than No. 1 should be used for important primary circuits. In many cities no wire smaller than No. 4 is ever used for primary circuits.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

We think the smallest size of weatherproof wire to use for an overhead city line is No. 6. Smaller, of course, can be used, but taking into consideration all conditions of weather, if a size smaller is used the chances of open circuits and broken wires are so materially increased as to more than offset the small saving that their use might effect on first installation.

F. G. PROUTT.

Number 6 B. & S. is about the limit, but No. 4 is better for high-tension lines. M. P. R., N. Y. ED. CO.

Number 4 B. & S. weatherproof wire. Some people think that No. 6 is all right for this purpose.

W. T. M., N. Y. ED. CO.

Number 8 is the smallest wire that should be used for overhead lines. E. F. MCCABE.

Number 6 for long lines and No. 10 for short lines.

AUGUSTA RY. AND ELEC. CO.

P 13. What factors should determine the size and numbers of feeders to be installed?

The number of feeders required to deliver the load of the station to the distributing network depends both upon the amount of the load and on its relative distribution through the territory supplied. A sufficient number of feeders must be installed to make it possible to distribute from the centre of distribution to the most distant customers without more than two per cent drop in the mains. In a district where the load is scattered, this will result in rather more feeders for a given load than would be necessary in feeding load in a business district, where the distances to be covered by the primary mains are so small that the feeders can be loaded much more heavily.

From the standpoint of interruption of service it is not advisable to load single-phase feeders above 150 kilowatts, as the blowing of a fuse interrupts the service of too many customers. On feeders supplying widely distributed load it is often not possible to carry more than 100 kilowatts with good distribution of pressure on the mains.

The most economical size of wire to be used for a feeder that is to carry a given maximum load, is that for which the sum of the copper losses, plus the fixed charges on the value of the feeder, plus fixed charges on the value of the station equipment required to supply the feeder losses at maximum load, is a minimum. H. B. GEAR.

Number of centres of distribution and the size should be figured from the possible amperage and distance.

A. PETERS.

Distance and load; 200 kilowatts being enough for 2200-volt circuit. W. H. GREENSLIT.

The two factors are the cost of power lost in drop and the expense of maintaining the feeders.

THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

The load and the distance to be transmitted.

HERBERT E. BRAGDON.

Load, distance and power factor, allowing liberal margin for increase of business. G. WILBUR HUBLEY.

The kind of load to be carried, whether motors or lights, that is, the feeders must be of such a size as to handle properly all fluctuations in load without exceeding the specified drop allowable. The number of feeders should be governed by same factor and also by the percentage of loss that a company is willing to stand yearly as an interest charge against its investment.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

First, the area to be supplied by a single feeder should be sufficiently limited to enable a reasonably uniform voltage to be maintained over the whole of it. The maximum advisable size for an alternating lighting feeder is usually limited by the increased reactance loss to from No. 0 to No. 0000 for 60-cycle systems. The maximum current per feeder is limited by allowing from 10 to 20 per cent maximum loss of voltage.

THE SEATTLE ELEC. CO.

Amount of business to be taken care of, permissable line loss, probability of future business, and cost of feeders.

W. G. CARLTON.

The size and number of feeders to be installed in any electrical system of distribution should be governed by the old saying: "Do not put too many eggs in one basket." About 100 kilowatts of load is as much as should be carried on any single set of feeders. F. G. PROUTT.

P 14. What is the advisability of dividing overhead line into sections by switches located in various districts?

We find it advisable, since it makes it easier to locate trouble and also permits us to operate the larger part of any circuit that may be in trouble until the same can be repaired.

In dividing up a system in which the neutral is grounded it is unnecessary and indeed inadvisable to open the neutral wire at such points. S. R. INCH.

This is usually an unnecessary complication, but is sometimes desirable in special cases. M. P. R., N. Y. Ed. Co.

It makes it very convenient to cut out any section for repairs, or in case of a fire it saves cutting the wires or shutting down the plant. Porcelain-plug junction boxes make the best switches for alternating-current work. F. W. Bullock.

This is a good idea and assists us in rapidly locating trouble.
Augusta Ry. and Elec. Co.

That they may be disconnected from main lines in case of fires or accidents to lines. W. H. Greenslit.

A circuit divided into sections has a twofold advantage. First, only one section will be out of service while trouble is being located; second only one section has to be gone over to locate the trouble. W. L. Sees.

Useful in cases of fire or repairs. If oil switches are used they have the advantage of being able to open under load.
W. H. C.

The switching plan is found, occasionally, to be very convenient in case of fire or serious trouble.
The Edison Elec. Ill'g Co. of West Chester, Pa.

We find that the installation of cutting-out switches on various sections of both our transmission line and our 2300-volt distribution system increases the reliability of our service as sections on which troubles show may be cut out until repaired without affecting the operation of the rest of the system. Cutting-out switches are very convenient to power stations giving 24-hour service in case extensive repairs or extensions are to be made, in which case the circuits on which the work is to be done can be killed during working hours. F. N. Averill.

To furnish an easy method of cutting dead a small part of a circuit, for necessary repairs, trouble, or cutting in new construction on to old lines. E. A. Vaughan.

It is a very good proposition to divide overhead lines into sections. Switches ought not to be used, however; a Noark junction box would be a better proposition.

H. J. MEYER.

For trolley system only. W. W. TITZELL.

It is advisable, if only for the easy locating of grounds.

A. R. MACKINNON.

In case of trouble it allows part of the circuits to be cut out for repairs, keeping the rest working, thereby stopping only part of the service. HERBERT E. BRAGDON.

Do not consider it good practice. G. WILBUR HUBLEY.

It is not advisable to divide overhead lines into sections by switches located in various districts, because it invites the possibility of interrupting continuous 24-hour service to your customers. DOUGLASS BURNETT.

Series arc lines can be divided to advantage by switches located in various districts. The benefit derived is, in case of a bad fire or open circuit in any district, the switch for same can be closed, thus cutting out the affected piece of line and closing the remainder of the circuit. Incandescent lines can also be divided to advantage in some places, for the same reasons as arc lines, but the advantage will not be so great, owing to open circuits being less frequent.

A. M. COVER.

P 15. Can not our overhead lines be made more reliable by increasing the spacing and sags where space is available?

Lines could be made more reliable by increased spacing, but better results could be obtained by decreasing the length of spans where that is possible. W. L. SEES.

Yes, by increasing the spacings but not the sag.

J. F C.

No. W. H. GREENSLIT.

I think not. F. C. S., MALDEN ELEC. CO.

Yes.
THE EDISON ELEC. ILL'G CO. OF WEST CHESTER, PA.

No. G. H. CUSHMAN.

Decidedly not. HERBERT E. BRAGDON.

They can be made safer, as well as more easily worked.
AUGUSTA RY. AND ELEC. CO.

P 16. What is the best distance apart for wires on 2200-volt circuits where circuits are in use 24 hours per day?

Forty inches at pole; 14 inches between pins.
W. W. TITZELL.

In the writer's judgment the two pins nearest pole (one on either side of pole) should be 24 inches apart, and from there out 12 inches between pins is sufficient. J. F. C.

Place pole pins 24 inches centre to centre, then outer pins 12 inches. A. PETERS.

Not less than two feet. W. H. GREENSLIT.

Depends on spacing of poles, but wire should run on adjoining pins. W. H. C.

We use a cross-arm with 13 inches between pins and 26 inches between pole pins. J. W. CARTWRIGHT, JR.

Ten to 12 inches.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

This depends entirely upon the method of construction. Some companies run both wires of the feeder on the same side of the arm, *i. e.,* on a six-pin arm, using the end pin and middle pin or the middle pin and pole pin on one side of the arm; other companies, which the writer thinks is the general practice, run lighting feeders on the pole pins or middle pin of each side of the arm. In the first case it does not make a great deal of difference what distance apart these wires are. The usual distance is about a minimum of 14 inches, but if they are run in the latter way, the minimum distance between pole pins should be 30 inches so these wires necessarily will be 30 inches apart. This practice is maintained for the sake of safety in working on wires. F. C. S., MALDEN ELEC. CO.

About 18 inches apart with slack well pulled up. The tighter, the better. HERBERT E. BRAGDON.

We have good results from 2300-volt circuit wires, 12 inches apart. E. J. BECHTEL.

Fourteen to 16 inches and a space of 22 inches at the pole. This space is for the linemen to ascend between the wires. This space is found to be good practice in line construction.

C. W. KOINER.

Thirteen inches. G. H. CUSHMAN.

Not less than four feet apart, as this leaves room for workmen to do necessary work on poles where wires are in use. This refers only to the space between wires adjacent to poles.

A. M. COVER.

Twelve inches is sufficient.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

One foot for outside wires, and 21 inches for wires next to the pole. M. P. R., N. Y. ED. CO.

P 17. Would it be advisable to tie high-potential wires with iron tie wires?

No, and emphatically no, if the iron wire is bare.

J. F. C.

No. W. H. GREENSLIT.

No; it would cause local electrolytic action to result.

G. WILBUR HUBLEY.

No. Tie wires of the same material as the line should always be used, in order to prevent local action between the tie wire and line wire.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Do not consider it advisable to tie high-potential wires with iron tie wires—First, unless well galvanized they would rust out very rapidly and at the same time destroy the insulation on the line wire. Second, they would cut into the insulation, thereby becoming a source of danger to linemen working on the pole.

A. C. GREENMAN.

No. W. W. TITZELL.

No, with a large N. HERBERT E. BRAGDON.

No objection if tied in such a way that two dissimilar metals do not come in actual contact. W. H. C.

No. F. C. S., MALDEN ELEC. CO.

In no case is it advisable to tie copper wire with iron ties. You will invariably find that your linemen will mark the copper with the iron ties, in which case you will be very likely to have shut-downs occasioned by broken wires.

F. N. AVERILL.

No. Iron tie wires would act as choke coils and would probably cause lightning to discharge through insulators and poles instead of following the line to the lightning arresters.

J. F. DOSTAL.

No. Iron is more likely to break in wrapping than is copper, and rusts away in a short time. M. P. R., N. Y. Ed. Co.

Iron wires would probably be put on tight enough to cut the insulation on the copper wire.
Augusta Ry. and Elec. Co.

P 18. Are best results obtained by fitting of pins in cross-arms in store-room, where painting shank of pin with white lead and fastening pin with a galvanized nail is easily done, or by leaving this fitting to linemen and not leading shank of pin?

By fitting pins in store-room. W. H. Greenslit.

We consider it good practice to fit lead and fasten such pins as we expect to use soon, but the pin-holes that we do not have immediate use for we leave open. J. F. C.

Think best results are obtained by fitting cross-arms with pins and braces in the store-room. A. C. Greenman.

We always pin all our arms in the store-room at the time of painting same. The pins are dipped in the paint that is used to paint arms with and driven in the pin-holes and fastened with a wire nail. This is, of course, on new material; where a pin is to be replaced on the line, it is done without removing arm. F. C. S., Malden Elec. Co.

The best results are obtained by painting shank of pin and then painting around pin after it is in place, to keep the water out. F. H. Ketchem.

The best results are obtained by fitting the pins in the store-room, if it can be done. However, there should be no difficulty in doing this work on the ground.
C. W. Koiner.

In our experience the best results have been obtained by putting pins in cross-arms in the store-room, as without some

kind of paint coating the pins rot rapidly and if there is a slight lifting strain, the pins will pull out, unless nailed in, and cause trouble.
E. A. VAUGHAN.

Paint arms with one coat of good lead paint before priming. After thoroughly dry dip pins in paint before driving in hole. Use short wire nail. Give arm finishing coat; paint thoroughly around shoulder of pin, using boiled linseed oil.
D. CLINTON SHAIN.

In store-room.
FRED B. SHARPE.

This work should be done in the store-room by linemen during weather when they can not work outside.
W. W. TITZELL.

The best results are obtained by fitting cross-arms in store-room. In case linemen are on the monthly pay-roll, it will cost practically nothing to fit up the cross-arms in the store-room on days when the weather will not permit line work to be done. Linemen can not be depended upon to fit up cross-arms properly when on the line work, because they do not carry all the material and tools to fit the pins and arms properly.
PAUL F. WILLIAMS.

A locust pin will last much longer than a cross-arm, so I see nothing gained in painting shank. But all pins should be nailed in.
HERBERT E. BRAGDON.

To prepare cross-arms in advance and properly fit pins, *et cætera,* is desirable.
G. WILBUR HUBLEY.

Fitting up in store-room.
H. BOTTOMLEY.

Arms should be fitted up in store-room, but it is questionable whether there is anything gained by leading shank of pin.
M. P. R., N. Y. ED. CO.

We fit pin and cross-arm on the line and dip it before putting it in.
AUGUSTA RY. AND ELEC. CO.

P 19. (a) What is best to do with overhead high-tension alternating-current lines where line passes through a good many trees and trimming is objected to? (b) Is there any satisfactory tree insulator in use?

We get very good results from a home-made tree insulator, consisting of a wooden batten made in two halves of one-inch by two-inch seasoned oak with corners chamfered on one side, and a half-inch plow one-fourth-inch deep on the other side, given two good coats of paint. We get these made in twelve-foot lengths, and cut them in pairs of various lengths to fit the requirements. If it is possible to get up the tree they can be put on line wires without interfering with service, by binding the two halves together with scrap magnet wire, and anchoring it on wire with insulating tape. J. F. C.

Raise lines above trees. W. H. Greenslit.

We have not been able to find a satisfactory tree insulator. Where it is impossible to trim trees we have raised or shifted wires to get clearance. In a few cases it has been found necessary to leave the trimming to the live wire.

W. L. Sees.

There are several good insulators on the market that are very satisfactory for 2000 to 3000-volt service.

F. C. S., Malden Elec. Co.

Use a tree insulator whose insulation is equal to that of any insulator on the line in all kinds of weather. I think there are one or two types that fill the bill where the size of limb admits of its installation. W. H. C.

It is better to go above or under the limbs of the trees. It is better to go above the trees with high-tension lines. In no case should high-tension lines be fastened to tree limbs with tree insulators, as it is only a makeshift and will eventually give trouble. If the wires can not be run above the trees they should go under the lower limbs and the limbs should be cut off for a distance of four or five feet from wires; but it is better to build lines away from trees is possible. C. W. Koiner.

Use rubber-covered wire, braided, and high poles. There should not be much trouble in turning the average tree if wires are 40 or 50 feet above sidewalk. D. CLINTON SHAIN.

Use long arms, good tree cable and wooden sleeves treated with paraffin. W. W. TITZELL.

Use wire with three-thirty-seconds-inch rubber wall and triple-braid cover, and where same comes in contact with tree limbs large enough to wear the insulation, cover with wooden moulding. WARREN PARTRIDGE.

There is no tree insulator that is entirely satisfactory. The only method that will give good results is to trim trees and clear lines entirely. G. WILBUR HUBLEY.

If you can not raise wires without great expense, we know of but one other thing to do. Put up a nice talk to the owners of trees; tell them that swaying will cause them to make contact with wires, and result in their being killed; that you are too much an admirer of trees to wish to see them destroyed, and would like their permission to carefully trim the tops sufficiently to remove all danger. If you can get one or two parties to grant this request, have a competent man do the trimming, and then your difficulty is half over with the other owners.

CHAS. H. PETERS.

Tree insulators are worthless; use tree wire for distributing circuits. For extra high-potential lines, buy the trees and cut them down or go above them. J. T. COWLING.

Avoid the neighborhood; or get permission to clip the trees to an extent satisfactory to yourselves.

DOUGLASS BURNETT.

Use high poles and run wires above the trees; or better still, move line and go around trees. There is no satisfactory tree insulator now made, and owing to movement of trees, and the amount of water on same in wet, stormy weather, none can be safely used. A. M. COVER.

We have used Brodie tree insulators with perfect satisfaction. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

It is better to pass around or over trees, as we find this the only sure remedy for grounds on trees.

AUGUSTA RY. AND ELEC. CO.

(a) A special tree wire with rubber core and three or four extra strong braids, is fairly satisfactory up to 2200 volts. (b) There is no really good tree insulator in use.

M. P. R., N. Y. ED. CO.

P 20. Are there any insulator troubles on alternating-current lighting circuits of 2200 to 3000 volts; on series alternating-current lighting circuits up to 7200 or 8000 volts?

Not to the writer's knowledge.

F. C. S., MALDEN ELEC. CO.

There should be no trouble from insultors for the voltage named above, as triple-petticoat glass insulators that will stand 10,000 volts can be purchased at from seven to seven and a half cents each. C. W. KOINER.

I have trouble in wet weather with 2200-volt and 6000-volt lines, caused by leakage over the glass.

F. H. KETCHEM.

No. J. F. DOSTAL.

Practically none with good double-petticoat insulators.

M. P. R., N. Y. ED. CO.

P 21. Is it practicable to run a telephone line on the same poles with 2300-volt lighting circuits within two feet of the other wires? If so, how often should such a line be transposed? How often when on the same poles with a 500-volt direct-current circuit?

No. W. H. GREENSLIT.

Yes; transpose about every five poles.

E. W. GOUGH.

It is practicable, but not good practice. The writer is familiar with a great amount of this kind of construction which seems to cause no trouble with the telephone service.

F. C. S., MALDEN ELEC. CO.

Good results are obtained on two different telephone lines run on poles with lighting circuits, one line being transposed every 1200 feet and the other line every 2500 feet.

W. L. SEES.

A telephone line can be run on the same poles with a 2300-volt lighting circuit two feet from same if the wires are transposed about five times per mile. This, I find, gives good service.

H. P. WOODS.

We have an eight-mile telephone line on the same poles with a 6000-volt line; some of the way it is on brackets on the end of the pole, some of the way on the same cross-arms, using a six-pin arm and four lighting wires and two telephone wires. I transpose every five poles, but care must be taken in transposing to carry the wires around the same way, so that one will be wound around the other in following the line. F. H. KETCHEM.

It is common practice to run a telephone line on the same poles with a 2300-volt line. Two feet is closer than is ordinarily run, but is allowable. The line should be transposed about every half mile. The same transposition will do if it is placed in proximity with the 500-volt line, but the induction of a direct current is negligible. H. J. MEYER.

Telephone lines should not be run closer than six feet, to a high-tension line, and more distance should be allowed if possible. The telephone line must be full metallic and should be transposed every 600 feet.

The same rule applies to 500-volt direct-current lines and telephones. A. M. COVER.

We have telephone circuits within two feet of several of our 2300-volt lines and have heard of no annoyance resulting therefrom to the telephone company.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

On 2300-volt lighting circuit a twisted pair would probably be the only way of giving satisfaction within two feet of the line. Transposing every five poles on 500 volts ought to be satisfactory. AUGUSTA RY. AND ELEC. CO.

Yes, if 2300-volt constant-potential circuits and ordinary city work, where the two sets of wires do not run a long distance together. Can not answer for a line of several miles in one stretch. ALEX. J. CAMPBELL.

P 22. Is it possible for telegraph wires to be affected in any way by direct-current mains (3-wire) at a distance of two feet?

It is not probable. W. H. GREENSLIT.

No. FRED B. SHARPE.

Do not think it would cause any annoyance.

J. F. DOSTAL.

Not unless they came in contact with the direct-current wires, as the direct-current system will cause no induction.

A. M. COVER.

Never heard of its happening.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

P 23. How shall we get rid of the effects of induction on our telephone wires on cross-arms two feet under our 11,000-volt 13-mile transmission wires?

Transpose the wires four times per mile. J. F. DOSTAL.

By frequent transposition. W. H. GREENSLIT.

If your telephone circuit is of metallic construction, on good insulators, transposed evenly and often, and absolutely free from even slight grounds, you should have no trouble with it. The smallest branches of trees touching your telephone line will ground it sufficiently to make it noisy.

We are operating a 20-mile telephone line constructed as above, on the same poles as our 22,500-volt line and it is clear as a bell. F. N. AVERILL.

Telephone line should be dropped down about 10 feet below high-tension wires, or as far as possible, and should be transposed every fifth or sixth pole. H. N. CRANDALL.

Transpose. FRED B. SHARPE.

Transpositions of the telephone wires at uniform distances of half a mile would probably make the induction effects referred to small enough to be overlooked. DUGALD C. JACKSON.

Lower the telephone wires to make a separation of at least six feet from the 11,000-volt lines, and transpose the telephone wires every 600 feet. A. M. COVER.

If the telephone wires be a twisted pair, place them in the same plane with the high-tension mains and to one side of these mains, *never* between them, and about two feet away if possible. By running the high-tension line on one side of a cross-arm and the twisted pair on the extreme other end of the cross-arm, no induction will be detected.

Where the high-tension line occupied both sides of a cross-arm and could not be moved, perfect satisfaction was obtained by running the twisted pair of telephone wires on the end of the cross-arm below. They had previously been on this cross-arm nearer the pole, and the noise necessitated the change.

Another scheme, when a twisted pair is not in use, is to run the telephone wire six feet below the power line on insulators fastened to either side of the pole itself. Transpose the wires every quarter of a mile and satisfactory results will obtain.

C. W. R., N. Y. ED. CO.

It is unsafe to run telephone lines within two feet of 11,000-volt transmission lines, as there will be a too high potential induced between the ground and the telephone.

AUGUSTA RY. AND ELEC. CO.

P 24. When two lighting companies are required to make joint use of certain poles, each having 2200-volt primary alternating-current lines and 220-volt secondary lines, which of the following arrangements of the wires is the safer? (a) A zone at the top of the pole for the high-pressure wires of one company, followed immediately beneath by the zone for the high-pressure wires of the second company, the low-pressure of the wires of the first company being then placed in a zone beneath the high-pressure of the second company, followed in their turn by the low-pressure wires of the second company; or (b) high-pressure wires of first company at top of pole, followed beneath by zone for low-pressure wires of this company, then by zone for high-pressure wires of second company, and finally by the low-pressure wires of second company.

It is the writer's opinion that the second arrangement of wires would be safer, as well as more desirable to the parties concerned, notwithstanding the fact that the company occupying the upper zone would be at a little additional expense to properly insulate its service wires where they drop through the lower company's primary wires. As to which company would occupy the lower or higher zone, that would be decided by the height of the different companies' poles leading to or from such joint poles.

J. F. C.

All high-pressure wires should be placed at top.

W. H. GREENSLIT.

It would seem as if there could be but one answer to this question, *i. e.,* high-tension wires of first company followed by their own low-tension wires, high-tension wires of second company with their own low-tension wires beneath. By this arrangement the linemen have only to take care of the high-tension wires about which they are working. W. L. K.

In the first arrangement any transformer taps would be run through the other company's wires. The second arrangement would be much better, because it groups each company's wires together, and by leaving a vacant gain between groups, ample clearance could be had. W. L. SEES.

Would prefer second method. G. H. CUSHMAN.

Arrangement (a). HARRY M. HOPE.

High-pressure wires of both companies should occupy top arms. W. W. TITZELL.

Would suggest that both companies use the same cross-arms with high-pressure lines above and low-pressure below, one company using, say, the north and east sides of poles and the other the south and west. J. F. DOSTAL.

The first arrangement is safer and preferable.
G. WILBUR HUBLEY.

Place the high-tension wires of both companies above all secondary wires. F. ELLWOOD SMITH.

Under the conditions noted we should think it advisable for the two companies to take two sides of the pole, each putting its high-tension lines on top and reducing the pressure as it comes down to the bottom.
AUGUSTA RY. AND ELEC. CO.

Where two companies distributing electric light and power use the same poles, the method marked (a) in the question is by all means preferable. F. G. PROUTT.

All low-tension wires should be under all high-tension wires.
M. P. R., N. Y. ED. CO.

P 25. Referring to Class "B," rules of National Board of Fire Underwriters, Section C, stating that service wires must be at least seven feet above highest point of flat roofs, should this apply to an Edison three-wire system with 500 volts between outside wires? Should not service wires at this low voltage be exempt from this ruling and a lesser amount than seven feet be approved?

No wires that will not clear a man's head should be allowed on a roof, as they are always liable to be the cause of an accident in the dark. They are especially dangerous to firemen.

W. L. SEES.

Service wires should not be exempt from this ruling, because the intent of the rule is to give head room between wire and roof. The element of danger from shocks is secondary to that of obstructing passage over roof. PAUL F. WILLIAMS.

Mr. J. C. Forsythe, chief inspector of the New York Board of Fire Underwriters, informs me that this rule is for the protection of firemen and applies to telephone, telegraph, electric and all other wires. W. W. TITZELL.

Less than seven feet always permits interference for which the lighting company has to pay expenses.

AUGUSTA RY. AND ELEC. CO.

P 26. (a) What provisions are made against high-tension wires falling across telephone, telegraph or other foreign wires at crossings? (b) What is the approximate cost of protecting one crossing?

Where our transmission lines cross foreign wires we place a pole as close as possible on each side of the lead we are crossing, and of such a height as will make the clearance of our wires above the lines we are crossing, one and one-third times the span. These poles are all double-armed, head-guyed together and to the next pole in the line each side of the crossing. This head-guying takes all strain off the transmission wires and if they break at the crossing they will not be long enough to reach the foreign lead. F. N. AVERILL.

Span wires over telephone wires. FRED B. SHARPE.

(a) Have in service 150 patent connectors. These connectors disconnect the wires from the line automatically at the time the wire breaks and allows the broken span to fall to the ground.

(b) The cost of installing these connectors, including cost of connector, will not exceed 60 cents per wire.

PAUL F. WILLIAMS.

(a) A pole is set on either side of the line to be protected, of sufficient height so that if the high-tension line breaks between these poles the ends will not be long enough to reach the telephone line.

(b) The additional cost approximates $10 per crossing.

J. F. DOSTAL.

P 27. Where high-voltage lighting wires (2500 to 6000 volts), telephone wires and municipal fire-alarm wires are all on one set of poles, should the telephone and fire-alarm wires be placed above or below lighting lines? Give reasons for opinion.

Telephone and fire-alarm wires should always be placed below lighting lines, since they are much more likely to break and fall than are the lighting wires. It is also safer for linemen climbing the pole to have the lighting wires above, since it is not necessary for the fire-alarm and telephone linemen to come near primary wires when they are above. A clearance of four feet should be maintained between the lower lighting wires and the upper telephone wires, if possible. H. B. GEAR.

High-voltage transmission lines should be on top of all others, since high-voltage lines are, as a rule, of stronger construction and more carefully insulated. Their strength makes breakdown less likely, and they are in that position safer from contact with other wires that may break. Working on low-tension circuits is also possible without exposing the linemen to contact with high-voltage lines. J. W. CARTWRIGHT, JR.

As a rule high-voltage lines are mechanically stronger than telephone or fire-alarm lines and are less liable to breaking, hence they should be put at the top. J. F. DOSTAL.

Place the high-tension lines on top, because when it is necessary to repair the telephone and fire-alarm wires a man does not have to go up through the high-voltage lines. Also, in case of three-phase transmission, the top of the pole gives better opportunity for the equal legs of the triangle. G. F. WILLARD.

Place the fire-alarm wires at the top of the pole, so that nothing can interfere with them. Place the telephone wires below the electric-light wires, because the electric-light wires are less liable to break and fall on the telephone wires than are the telephone wires liable to break and fall on the electric-light wires; also, because by this arrangement the telephone employees do not have to climb up through the high-potential wires.

F. ELLWOOD SMITH.

Telephone and fire-alarm wires should be below lighting wires, because they are more apt to break. J. T. COWLING.

The fire-alarm wires should be on the top of the pole, as they rarely need any changing and workmen need not work as much with same as with the electric-light wires; they should be at least four feet above the electric-light wires.

The telephone wires should be placed six feet under the electric-light wires, and in the form of cable instead of open wires, as same will be very heavy if many telephone wires are needed. This also gives workmen a chance to work on either the electric-light or the telephone lines without coming in contact with other wires. A. M. COVER.

To minimize danger from broken wires coming in contact with electric wires, fire-alarm and telephone wires should always be placed under high-voltage wires; the breaking of the former small-sized wire is much in evidence as compared to the breaking of electric wires. C. C. GARTLAND.

Telephone and fire-alarm wires should be below high-tension wires, because the latter are always larger and less likely to break; also because linemen would not have to climb through high-tension wires to reach the others.

M. P. R., N. Y. Ed. Co.

The high-voltage lighting wires should be placed above all the other wires. The mechanical strength of these wires is greater, and for this reason they should be placed on top, otherwise the weaker wires might fall across the high-potential wires.

W. T. M., N. Y. Ed. Co.

The fire-alarm and telephone should be below the high-voltage wires, because of fewer breaks taking place in high-voltage wires on account of size of same, and telephone linemen not familiar with high-voltage service should not pass through said lead to get to their wires. E. A. Bechstein.

Locally, we prefer, and the telephone company prefers, to have its wires on top and ours below. Our reasons are that the lower heavy wires are placed, the less strain on the poles and the easier the wires are to handle. The heavy wires are more difficult to stretch taut, and the sag and strain may allow them at times to touch other wires placed underneath them.

For reasons for doing the other way, see A. V. Abbott, *Telephony,* Part Four, *Aerial Lines,* page 28, *et seq.*

Alex. J. Campbell.

Where high-voltage wires and fire-alarm wires run on the same pole I would advise that the high-tension lines be placed on the top of the pole, because they usually consist of No. 0 wire and are less liable to break than the small sizes. Again, the fire-alarm and telephone linemen would have no occasion to climb through the high-tension lines in order to make any repairs.

John J. Gaffney.

P 28. (a) What form of device for disconnecting overhead wires from underground cables for the purpose of testing has

been found safe and easy to handle? (b) Do you consider it advisable to place such device on cable poles?

Weatherproof oil switch with lead-sheathed cable made into box with wiped joint and aerial wire brought out through sealed bushing. May be operated under full load and safely installed on any pole. W. H. C.

For lines carrying not over 25 amperes, standard types of porcelain transformer fuse blocks can readily be placed on the terminal poles, so that overhead and underground sections can be quickly disconnected. These boxes can be fused if desired, or fitted with copper wire and used simply as disconnecting plugs.
WARREN PARTRIDGE.

It is considered poor practice to have any device, except a good soldered joint, for disconnecting the overhead lines from the underground cable. H. J. MEYER.

(a) I use a knife switch and find it very satisfactory. (b) Yes. HERBERT E. BRAGDON.

We have used single-pole knife switches at points where underground cables meet the overhead wires. These switches are thoroughly insulated and located in the manholes. We find them very useful when we desire to locate grounds on either the overhead or underground lines. UNITED ELEC. LT. CO.

Disconnecting switches placed in weatherproof houses on poles have been found satisfactory.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

In connecting underground line to the aerial line we run cable up pole to the weatherproof box; we place pot-heads inside of box and run cable through the bottom of box and use an extra heavy insulated wire inside the box and make connection by means of a large connector, and when made we cover up connection with an insulated tube. In case we wish to disconnect cable from aerial line we raise this insulated tube and that allows us to do the work. JOHN J. GAFFNEY.

P 29. What forms of potheads or joints have been found satisfactory for connection between overhead and underground lines for voltages ranging from 1000 to 5000?

A pothead consisting of a 1.5-inch porcelain tube set over the joint between the lead cable and the line wire has been found very satisfactory after a year and a half of service. The cable enters the bottom of the tube, the annular space between the cable and the tube being filled with a wooden block to hold the compound while it is being poured into the tube. The conductor from the pothead to the line wire is extra-heavy rubber-covered stranded cable and the top of the bushing, after it has been filled with compound, is built up with tape and compound around the rubber conductor in the shape of a cone, so that no water can accumulate on the top of the joint. The tube is attached to the cross-arm by means of an ordinary metal strap, near the wire to which it is connected. H. B. GEAR.

At present we are using a pothead made by slipping a 1.5-inch by 12-inch porcelain tube over joint and filling the same with No. 2 Minerallac, taping up the ends and painting the whole with P. & B. insulating paint. As we have had none of these joints in use more than ten months, they have not had a thorough test, but have given satisfaction to date.

W. L. SEES.

No pothead is necessary up to 2500 volts, ordinary coupling or sleeve joints being all that is necessary. Above 2500 volts the standard form of bell-shaped pothead is advisable, protecting same from weather by a suitable weatherproof house.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

I use rubber-covered wire and a lead pothead filled with compound, protecting it from the weather with a small wooden box, and have had no trouble from their use. A lead pothead not protected is liable to freeze and expand the lead and then the dampness works down into the cable and burns it out.

HERBERT E. BRAGDON.

We have found potheads made out of lead sleeving about twice the size of the cable. It worked very satisfactorily.

JOHN J. GAFFNEY.

P 30. What insulation resistance should be required in testing high-tension lines subject to a voltage of 2000, 4000, 7000 or 14,000? Should a breakdown test be made on such lines? And what voltages should be used in the test?

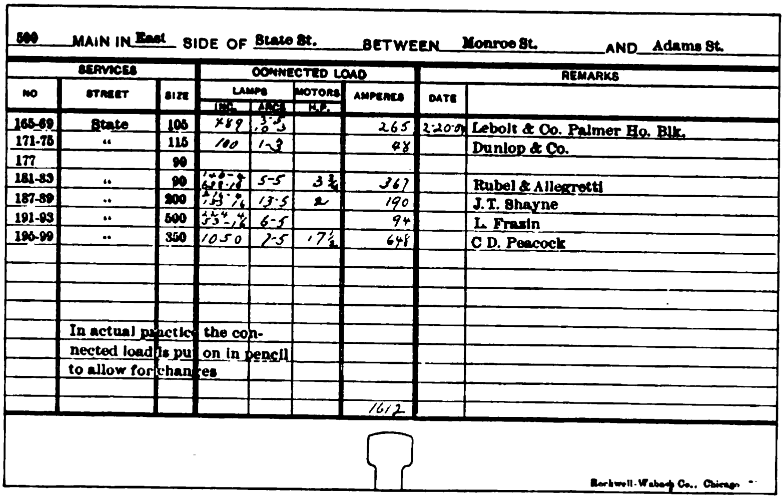
A fair insulation test for either an overhead or underground line is to test at a voltage 50 per cent in excess of the normal line pressure for a period of one minute. On overhead lines operating at below 5000 volts it is not necessary, as a rule, to make any insulation test. W. G. CARLTON.

In making breaddown tests on the 13,000-volt transmission line we used 25,000 volts for five minutes. JOHN J. GAFFNEY.

P 31. How should records of connected load on feeders, mains, transformers and secondaries be kept, so that it will be flexible, accurate and easy to refer to? Illustrate by sample of cards used.

A simple way of computing the connected load of feeders and mains consists in the use of an outline diagram of the lines, using a small circle to show the transformers. The size of the transformer is marked in pencil, to permit of making changes easily. The connected load in kilowatts of transformer capacity can be determined from such a map at any time with a few minutes' work if the transformer data are kept up to date. There are various card systems for keeping track of the load on transformers and secondaries, which are very good. In a large system with three-wire secondaries it is valuable to have maps of a scale of sufficient size to show the location of the poles and service taps. Two and three-wire services can readily be seen and the balance and distribution of load on the secondaries be kept track of, H. B. GEAR.

Samples of cards used by the Chicago Edison Company are shown below. W. G. CARLTON.

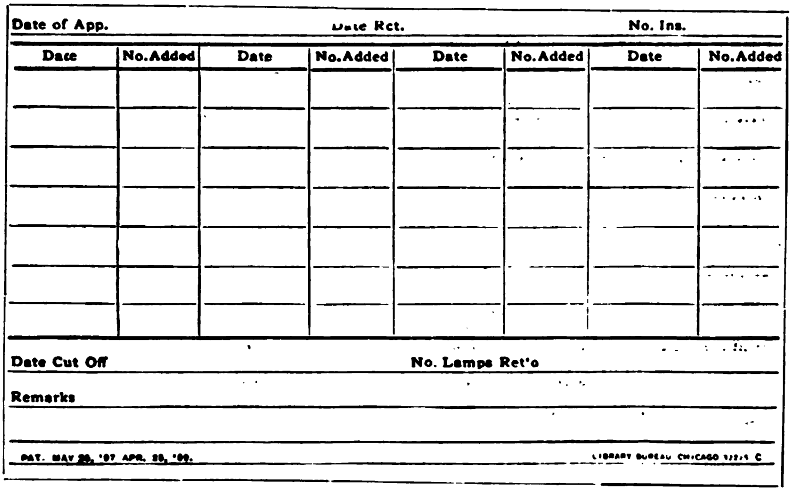


500 MAIN IN East SIDE OF State St. BETWEEN Monroe St. AND Adams St.

SERVICES			CONNECTED LOAD				REMARKS	
NO	STREET	SIZE	LAMPS INC.	LAMPS ARCS	MOTORS H.P.	AMPERES	DATE	
165-69	State	105	489	3-5 10-3		265	2-20-04	Lebolt & Co. Palmer Ho. Blk.
171-75	"	115	100	1-3		48		Dunlop & Co.
177		90						
181-83	"	90	140-4 628-18	5-5	3¾	367		Rubel & Allegretti
187-89	"	200	215-9 133-16	13-5	2	190		J.T. Shayne
191-93	"	500	224-4 53-16	6-5		94		L. Frazin
195-99	"	350	1050	7-5	17½	648		C D. Peacock
						1612		

In actual practice the connected load is put on in pencil to allow for changes

Rockwell-Wabash Co., Chicago



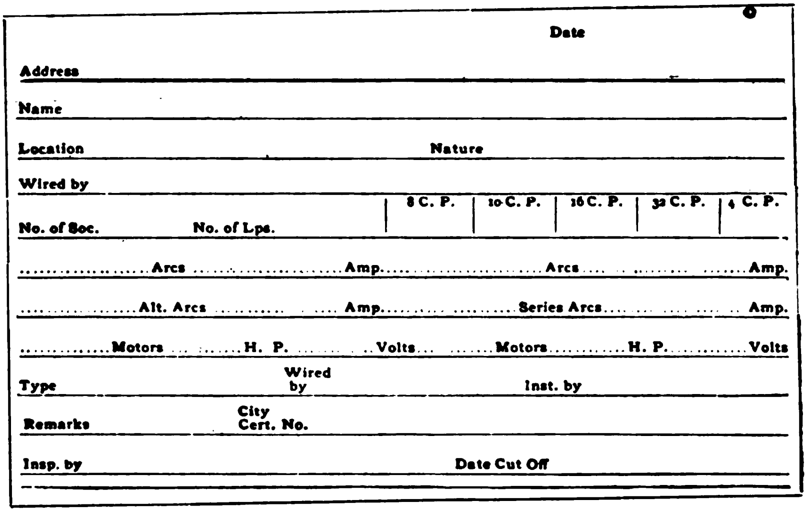
Date of App. Date Rct. No. Ins.

Date	No. Added	Date	No. Added	Date	No. Added	Date	No. Added

Date Cut Off No. Lamps Ret'd

Remarks

PAT. MAY 25, '97 APR. 28, '99. LIBRARY BUREAU CHICAGO 1121 C



Date

Address

Name

Location Nature

Wired by

8 C. P. | 10 C. P. | 16 C. P. | 32 C. P. | 4 C. P.

No. of Soc. No. of Lps.

..................Arcs ....Amp..................Arcs ....Amp.

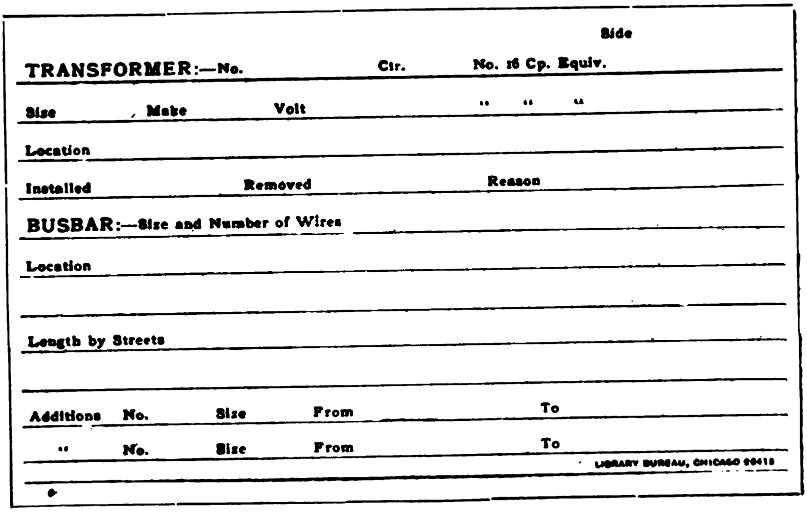
..................Alt. Arcs ....Amp..................Series Arcs..................Amp.

..............Motors ....H. P. ....Volts..........Motors............H. P.............Volts

Type Wired by Inst. by

Remarks City Cert. No.

Insp. by Date Cut Off



Side

TRANSFORMER:—No. Ctr. No. 16 Cp. Equiv.

Size Make Volt " " "

Location

Installed Removed Reason

BUSBAR:—Size and Number of Wires

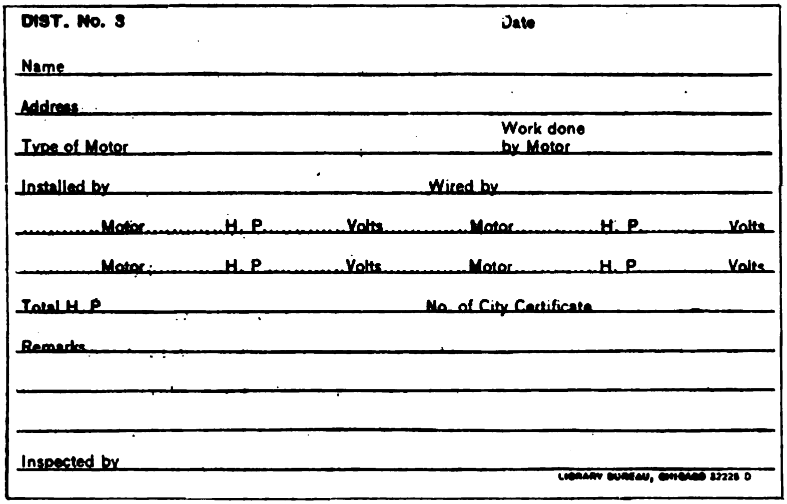
Location

Length by Streets

Additions No. Size From To

" No. Size From To

LIBRARY BUREAU, CHICAGO 20418



DIST. No. 3 Date

Name

Address

Type of Motor Work done by Motor

Installed by Wired by

Motor H. P. Volts Motor H. P. Volts

Motor H. P. Volts Motor H. P. Volts

Total H. P. No. of City Certificate

Remarks

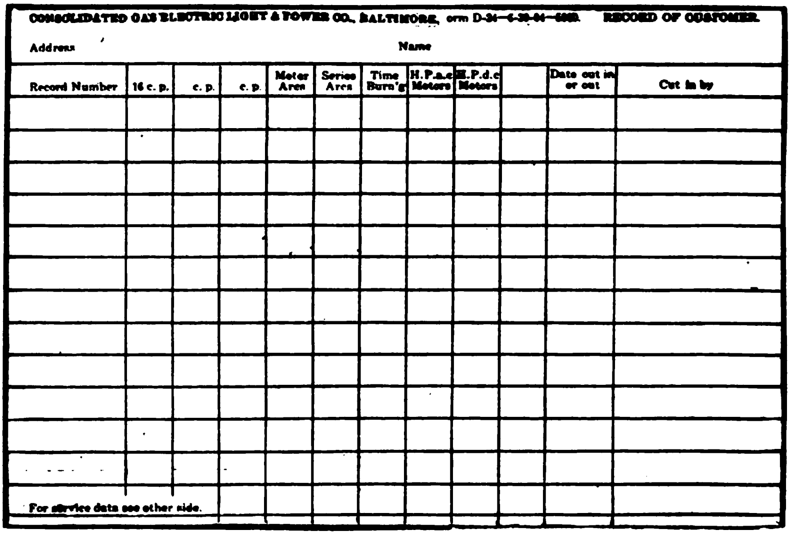
Inspected by

LIBRARY BUREAU, CHICAGO 37228 D

Give every transformer a number, irrespective of manufacturer's number, and paint on transformer in large enough figures to be legible from the ground. Using a loose-leaf ledger, give every transformer a page or more, with the description of transformer, names and addresses of consumers connected, with the amount connected—counting each 16-cp lamp at 0.05 kilowatt consumption—and whether consumer is on flat or meter basis. It will be found that for residence districts the transformer must be large enough to take care of the total connected load when all connected are on flat rates, but if on a meter basis, the transformer may have a capacity of 25 per cent of the total connected load. With every "connect up" or "disconnect" order the lineman turns in the transformer number.

THE COLORADO SPRINGS ELEC. CO.

Keep a card index of your customers in your operating department, with information with regard to your customers' installation on the face of the card, and with information with regard to the feeder, 'bus line or main, the transformer, meter and station on the back. In other words, the face of the card should show the installation, the back the service record. See



CONSOLIDATED GAS ELECTRIC LIGHT & POWER CO., BALTIMORE, orm D-34—6-30-04—5000. RECORD OF CUSTOMER.

Address Name

Record Number	16 c. p.	c. p.	c. p.	Meter Arcs	Series Arcs	Time Burn'g	H.P.a.c Motors	H.P.d.c Motors		Date cut in or out	Cut in by
For service data see other side.											

	Alternating.	Series Arc.	220-Volt Power	3-Wire Direct.
Circuit or Feeder No.				
From Station				
	Cycles	Amp.		
Transformer				
Voltage of Service				
Location of Service				
Size of Conductors				
Meter				

sample enclosed. Better arrange them geographically, that is, according to (a) streets; (b) separate meter and a transformer record.

Douglass Burnett.

P 32. What is the best method of keeping record of location, size, etc., of overhead lines? Describe a desirable system of symbols for poles and lines.

Small companies serving but four or five square miles of territory will find maps of 400 or 500 feet to one-inch scale suited to their needs. Larger companies, covering from 10 to 25 square miles, will find it more convenient to use maps in atlas form. Where a system of secondaries is run, subject to frequent changes and consequent erasures, it will be more desirable to record location of poles in a separate atlas (or pages), using maps of 200 feet or 100 feet to inch scale. In large cities, where it is the custom among public-service corporations to exchange "contact" privileges with each other, the problem of records is more complicated. In this case adopt symbols indicating ownership of poles used, record adjacent thereto, job or index numbers, by reference to which entire correspondence or history of each contact privilege may be made immediately accessible with only a minimum loss of time. Where lines of several systems are run in close proximity to each other, use colored inks (waterproof) to emphasize distinction between them. Show adjacent to these lines, sizes of conductor, current or system, *et cætera*.

●	Poles owned by electric light company.
ED.CO. ◓ W.U	Poles in which electric light company may have a joint or half interest. Relative position of initials will indicate company having prior claims or original right of way.
○ CITY	Poles on which contact privileges have been leased from city (or other company).
—·—·—·—·—	Primary circuits of single, 2 or 3-phase, *et cætera.*
————————	Secondary lines.

The series of symbols given herewith are used by one of the largest American companies. A multiplicity of symbols should be avoided, as it increases probability of errors, and consequently diminishes the value of the system as an exact record.

F. S. CHANDLER.

A map is the best way of keeping a record of overhead lines. Feeders, primary and secondary, can be designated by different colors and different classes of rulings, and the size of wire can be plainly marked. In addition to the map, an indexed record of streets on which there are mains can be kept, giving the length of line and size of wire. H. J. MEYER.

Card for each pole, with diagram, number of pole, gauge of wire, number of circuit, and pin each wire occupies.
W. W. TITZELL.

Use one of the many card systems now in use.
UNITED ELEC. LT. CO.

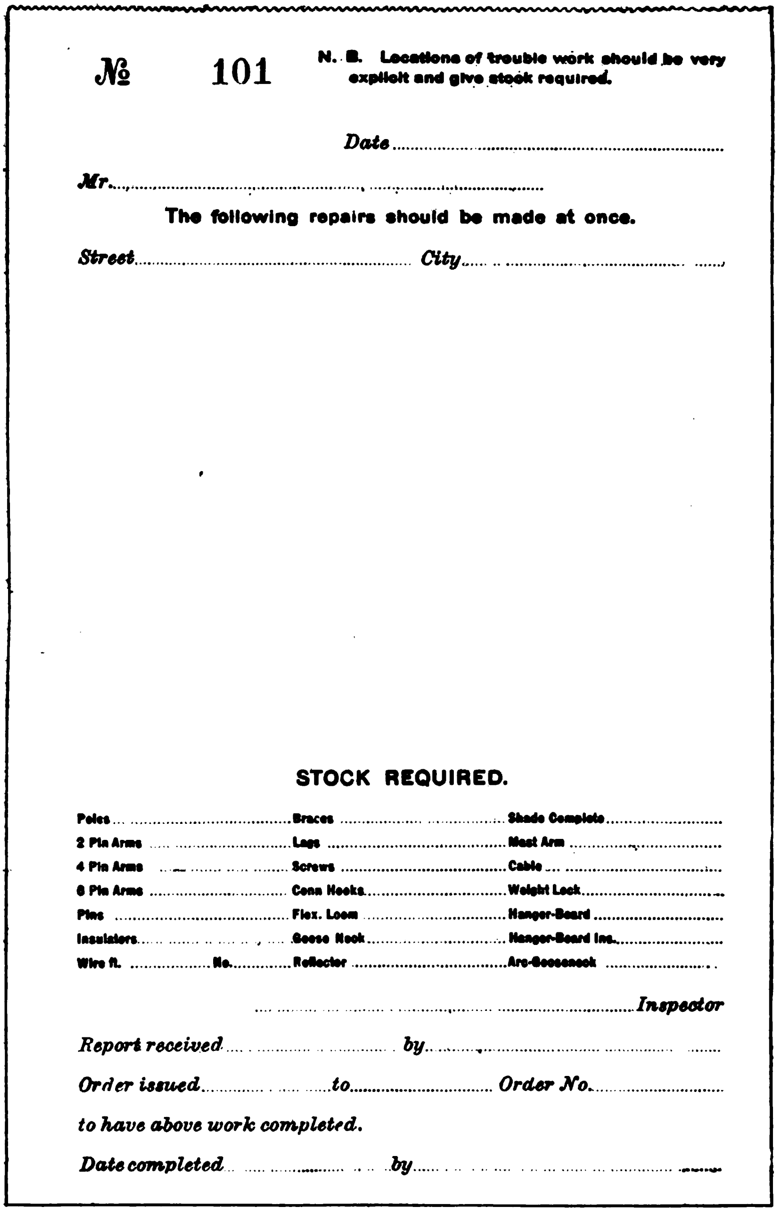
Have a board background and paste a map over this. Use wire nails for poles and different sizes and colors of twine string to represent the different circuits. F. W. BULLOCK.

P 33. What method of taking and recording data constitutes the most accurate means of determining the resistance losses in both primary and secondary systems of distribution where the circuits are always alive?

P 34. Have you any system of regularly inspecting pole lines? If so, what records are kept showing the condition of the lines at time of inspection?

A system of regular inspection is maintained in the city of Chicago by which all overhead lines are covered once in three months, and important leads oftener. The inspector is an experienced lineman who makes special note of the condition of wires, pins and insulators, cross-arms and poles with reference to their causing interruption of service; also the clearance between lighting mains and signal wires at all points where they intersect without the use of a junction pole; the condition of lightning arresters, fuse boxes and ground wires. The diagram showing the clearance at each intersection of foreign wires is kept on file and note is made of the date of subsequent inspections on the back of this sketch. H. B. GEAR.

Yes. Attached are forms that we use for this purpose.



№ 101

N. B. Locations of trouble work should be very explicit and give stock required.

Date ....

Mr. ....

The following repairs should be made at once.

Street .... *City* ....

STOCK REQUIRED.

Poles ....
2 Pin Arms ....
4 Pin Arms ....
6 Pin Arms ....
Pins ....
Insulators ....
Wire ft. .... **No.** ....

Braces ....
Lags ....
Screws ....
Conn Hooks ....
Flex. Loom ....
Goose Neck ....
Reflector ....

Shade Complete ....
Mast Arm ....
Cable ....
Weight Lock ....
Hanger-Board ....
Hanger-Board Ins. ....
Arc-Gooseneck ....

.... *Inspector*

Report received .... *by* ....

Order issued .... *to* .... *Order No.* ....

to have above work completed.

Date completed .... *by* ....

№ 401 *Date*..

Mr...

I have to-day inspected transformer and all secondaries wires supplied from same,

Transformer No................... *Size*.................. *Street*..................

Cr................... *opp.*.................. *City*..................

and recommend the following work to be done.

STOCK REQUIRED.

Poles..................
2 Pin Arms..................
4 Pin Arms..................
6 Pin Arms..................
Pins..................
Insulators..................
Wire ft.................. No..................

Braces..................
Lags..................
Screws..................
Conn Hooks..................
Flex. Loom..................
Goose Neck..................
Reflector..................

Shade Complete..................
Mast Arm..................
Cable..................
Weight Lock..................
Hanger-Board..................
Hanger-Board Ins..................
Arc-Gooseneck..................

.... *Inspector*

Report received.................. *by*..................

Order issued.................. *to*.................. *Order No.*..................

to have above work completed.

Date completed.................. *by*..................

F. C. S., Malden Elec. Co.

We inspect our pole lines once a year, very early in the spring, and examine the poles at surface of ground very carefully, making notes of all defects needing attention within the year. These notes are brought to the office and arranged in wards; a sheet is then made out for each ward and after the work is done the sheets are filed. J. F. C.

Divide the lines into sections or districts; have every pole in each section numbered. The number of inspectors necessary depends entirely on local conditions. If the line is constructed in good shape, using good substantial material, it does not require as much attention as a poor line. D. CLINTON SHAIN.

Every employee is an inspector who reports each day any defects discovered. A thorough inspection of each pole is made once a year by a competent lineman. W. W. TITZELL.

A—All work and maintenance of this character is under charge of the superintendent of distribution. *B*—Installation and repairs are under the charge of the general foreman of the gang doing the work, and reporting to the superintendent of distribution. *C*—An inspector of overhead lines, whose duty it is to report any defect, either actual or prospective; reporting to superintendent of distribution. *D*—A chief inspector with authority to investigate all defective conditions of the company; reporting to the manager. This man also handles claims arising from accidents or damages. DOUGLASS BURNETT.

We have inaugurated a very successful system of line inspection. The city is divided into a given number of inspection routes, one of which is covered by the line gang each week. A report of all troubles found is made in writing by the line foreman, and is recorded in a card catalogue, classified by inspection routes and under routes by streets or locations. In this way the condition of the lines and poles may be very carefully followed, and the result is fewer breakdowns and less expense than formerly for line inspection and repairs to lines, owing to the fact that the comparative frequency of inspection makes it possible to repair defects before any serious trouble has arisen.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

We inspect all lines every three months; make up estimates of repairs necessary. AUGUSTA RY. AND ELEC. CO.

Yes. We have a regular inspector who does nothing but inspect poles, cross-arms and wires, and a daily log book is kept, showing the condition of all lines at the time of inspection. Minor repairs are sometimes made by this inspector.

W. T. M., N. Y. ED. CO.

We send a practical lineman out with the pole-record clerk; he tests the poles and if he finds any that need replacing, the pole-record clerk records same and after consulting with the superintendent orders them changed. We make an inspection once every year. JOHN J. GAFFNEY.

P 35. What should overhead repairs cost per annum per kilowatt-hour sold?

The average cost of repairs on overhead lines should not exceed 0.09 cent per kilowatt-hour sold.

G. WILBUR HUBLEY.

They do cost between five and ten per cent of original investment, not including copper investment, according to the soil the poles are set in, and the elements to which the cross-arms and pins are subjected. J. F. C.

The cost of overhead repairs per kilowatt per year should be about .55 cent. JOHN J. GAFFNEY.

P 36. (a) What is the average life of yellow-pine cross-arms? (b) Cypress cross-arms? (c) White-pine cross-arms?

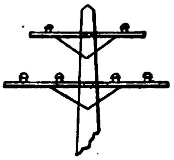
In this locality yellow pine cross-arms of a good quality will last about five years unpainted, but by dipping them in a composition known as *Barot* (a kind of creosote that is a non-conductor for the average voltage not exceeding 1150 volts) the life is very much longer. Cypress does not last here at all, and is not very strong. White pine is too expensive, so have never tried it. FRED M. LEGE, JR.

P 37. Is it good practice to carry more than one high-tension, 3-phase circuit on a single pole line?

We have carried two circuits, 30,000 volts, three-phase, on one pole line for four and one-half years. We have not as yet had any serious trouble. H. J. Gille.

Yes, if it is impossible to build two pole lines.
Harry M. Hope.

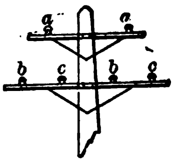
Yes; arranged as shown in diagram.



Fred B. Sharpe.

Where the cost of a duplicate pole line is prohibitive, the next best thing is to have two distinct circuits on the same pole line, using two cross-arms of proper dimensions, and running the three wires of each circuit in triangle, one complete circuit on each side of pole. Unless the voltage is enormously high, one circuit may then be continued in service while the other is opened for repairs or connections. Ralph D. Laxton.

It is good practice to carry at least two high-tension three-phase circuits on a single pole line, constructed as per sketch, or with cross-arms *vice versa*. H. N. Crandall.



The writer does not consider it good practice except in cases where lines are particularly free from trouble. Where the lines traverse a rugged country, with possibility of frequent line trouble, two separate pole lines, of one circuit each, are preferable.

L. O. VESER.

It is good practice to run two high-tension, three-phase circuits on single pole line. They can be symmetrically arranged by using two cross-arms and having one circuit on each side of the pole, one wire on the top arm, two wires on the bottom arm of each circuit. H. J. MEYER.

The carrying of more than one high-tension circuit on a single pole line becomes less desirable as the operating voltage increases. With line voltages above 15,000 or 20,000 volts, it is difficult to make repairs on one of two lines carried on the same poles if one of the lines breaks down and it is desired to continue the service over the other line. At pressures of 30,000 volts and above, repair work on one line while the second line remains in operation is practically impossible, and in such cases there may be a decided advantage in putting up two separate pole lines, each one to carry a single transmission circuit only.

H. H. BARNES, JR.

As one high-tension line can not be repaired safely while another high-tension line on the same pole is alive, it seems to me poor policy where the line is well made and inspected, to put two lines on one pole. AUGUSTA RY. AND ELEC. CO.

This depends upon the voltage on the circuits, the condition of the country traversed, the weather conditions, the operating conditions and the financial conditions of the company.

With heavy line construction, a good right of way, poles not over 90 or 100 feet apart, and lines not nearer than 36 inches, centre to centre, I consider it good practice to carry two transmission lines on one pole. This should be avoided, however, if possible, as better service can be maintained by using independent pole lines. A. BALSLEY.

This depends on the voltage of the circuit, and the amount of power transmitted; on the amount of money available for construction of lines; also on the room available for lines

Where a large amount of power is to be transmitted at a high voltage it is desirable, as a matter of safety, to have two separate pole lines, although there might be more than one circuit on a single pole line. W. G. Carlton.

P 38. In running a transmission line through the country, is there sufficient gain in using insulated wire to warrant the extra cost?

No. Fred B. Sharpe.

It is useless to use insulated wire on high-tension transmission lines. H. N. Crandall.

Think not on potentials exceeding 2000 volts.
Ralph D. Laxton.

The use of insulated wire for a transmission line in an open country has no advantage over the use of bare wire. The insulating supports must in any event be depended upon for the insulation of the line, and the line ought to be carefully prevented from coming into contact with trees or other objects that might cause grounds or crosses. Dugald C. Jackson

No; it would be a poor investment, with no advantages.
L. O. Veser.

For high-tension work, I do not think anything is gained by insulated wires. H. J. Gille.

No, you should never use insulation on high-tension wires when run in uninhabited districts, and I have never been able to see the advantage of its use anywhere, as 1000 volts will penetrate three-braid weather covering during a rain and to a great extent when dry if the contact is good; but it is a great help among trees. Still, I am of the opinion that we shall all see the day when it will not be used where the high-tension wires are used in cities and towns, but the companies will have the right to trim trees so as to prevent grounds and shorts.
Fred M. Lege, Jr.

No. Cutting all trees is the only assurance of freedom from trouble. AUGUSTA RY. AND ELEC. CO.

There is no advantage in using insulated wire for high-voltage transmission lines. W. G. CARLTON.

P 39. Where the underground and overhead on a 3-phase 15,000-volt transmission line meet, what would be the limit of distance away from the riser that one might install arresters or static dissipators with good effect? Would there be any objection to one arrester for one phase on each of three consecutive poles beyond the riser, the poles being spaced about 100 feet apart?

My opinion is that the best construction would be to provide a lightning-arrester or cable-terminal house in which the choke coils, lightning arresters and cable terminals could be properly installed. H. J. GILLE.

Experience has demonstrated that no set rules can be laid down for lightning-arrester installation. Their proper disposition for obtaining the maximum protective effect depends upon the local conditions, such as contours of district covered by the lines, the prevalence of trees or buildings that may tend to dissipate the charge, and the character and severity of the lightning discharges.

Good practice demands that some form of weatherproof protection, usually a small substation, be provided for high-tension protective devices, in which case, the lightning arresters will, of course, be banked adjacent to the riser. In the case cited, choke coils will probably be necessary to protect the underground cables.

A very good article appeared in the *Electric Club Journal* for March, outlining a system of test for determining the protection afforded by lightning arresters. This involves comparatively little trouble, and would probably be of considerable value in the average high-tension transmission. M. CARRINGTON.

P 40. Would there be any objections to installing a 220-440-volt overhead distributing system in a small town having so many trees as to prohibit the installation of a 2300-volt system without excessive trimming?

The objection to installing a 220-440-volt overhead distribution is that if the system covers very much territory the loss is too great or the cost of copper is prohibitive. I would not advise 220-440-volt distribution if the lines are more than 2000 to 2500 feet from centre of distribution. Even with low voltage the leakage is considerable, especially in localities where there is considerable rain. H. N. CRANDALL.

None, provided neutral wire is grounded and distances not prohibitive. In some cases the increased all-day efficiency of a direct-current plant of this character over one of 2300 volts alternating would more than offset the increased cost of copper and construction. RALPH D. LAXTON.

Best system of distribution would depend on the general layout of the town, as to location of customers with reference to each other and to the generating station; also upon the prospect of future growth of business.

Primary wires can be run through trees without trimming. See answer to question P 19.

The use of a limited amount of this construction, which is of course expensive, might make it possible to reach a number of centres of distribution in various sections of the town where transformers could be placed and the adjacent territory fed by 110-220-volt secondaries. WARREN PARTRIDGE.

A system using a three-wire, 220-440-volt distribution is entirely practicable for use in small towns, and is being used in various small towns with marked success. Its installation is sometimes less expensive than a 2300-volt system, since the former does not call for any expenditure for transformers. It is extremely important, however, to inspect all house wiring with a great deal of care when it is directly associated with a 440-volt circuit. The 440-volt pressure is also of doubtful advantage for house-to-house distribution, on account of the serious shocks that may be received from it unless the wiring and fixtures have been inspected with great fidelity.

DUGALD C. JACKSON.

The low-tension system would be preferable.

DOUGLASS BURNETT.

You will find that a great amount of copper will be necessary if your city is very badly scattered, and the use of 220-volt lamps is still expensive where you have a very great variation in your voltage, owing to the delicacy of the filament; the 220-volt lamp is yet some distance from perfection.

I should recommend 2300 volts and the use of split glass insulators to go through the trees or over them. By smooth talking you should be able to get an ordinance passed to permit the trimming of trees, as little as possible, so as to prevent grounds. You will find that a tree is not an exceptionally good conductor, except in places where you have a great deal of rain.

FRED M. LEGE, JR.

The line loss would be the principal objection.

AUGUSTA RY. AND ELEC. CO.

I do not think that the number of trees should determine the voltage, as a 2300-volt line can be carried over the trees on tall poles, carried through the trees and held by proper tree insulators, or suspended over the centre of the street on cross suspension. If, however, the town is small, the 220-440-volt system will be entirely satisfactory, and the first cost will be less than that of a 2300-volt alternating-current system. Care should be taken to equalize the voltage and feed lights from a centre of distribution. A. BALSLEY.

The leakage on a 220-440-volt overhead system, on account of wires passing through trees, would not be a serious matter even in wet weather. W. G. CARLTON.

P 41. What is the best combined switch and cut-out to use on aerial lines of 2300 volts, where a tap carrying 15 amperes or more is taken off a main line?

P. & S. porcelain plugs for junction poles.

FRED B. SHARPE.

Standard types of porcelain transformer fuse blocks will serve admirably as combined fuses and switches on 2300-volt taps.

WARREN PARTRIDGE.

Primary cut-outs, such as are furnished with large transformers by Westinghouse or General Electric Company, give excellent service, though they are sometimes exploded by lightning.

RALPH D. LAXTON.

For taps up to and including 15 amperes the usual forms of porcelain transformer cut-outs with aluminum fuses have been found very satisfactory. For larger taps it is usually preferable to connect them up with any of the standard forms of fuse box equipped with copper wire instead of fuse wire, the fuse box being used merely as a switch in locating trouble. It is better to have the station fuses take care of any short-circuits that may come in on the larger mains than to attempt to fuse them on the poles.

H. B. GEAR.

The best means of switching or cutting out from 3000-volt taps carrying 15 amperes or more is by use of small oil-break switch. This switch is thoroughly weatherproof and is made to be attached to cross-arms substantially the same as primary cut-out boxes. Such a switch is made and can be obtained on the market.

W. E. HOLMES.

General Electric type 2300-volt, 30-ampere plug cut-out, the same as used on transformers. They enable you to fuse and cut your circuit out without endangering your employees.

FRED M. LEGE, JR.

We have found the porcelain fuse block to be the handiest for comparatively small capacity.

AUGUSTA RY. AND ELEC. CO.

P 42. If a 3-phase grounded system is originally installed, protected from lightning and static by a proper number of arresters on each wire to ground, and later the star point of the generators is grounded, what changes would you make in your arresters?

If the original installation of lightning arresters is designed to take care of pressure from phase to phase, the connections on the arresters could be changed so as to include only enough gaps in the arrester circuit to take care of the pressure from the phase wire to the ground after the star point of the generator is grounded. H. B. GEAR.

Grounding the star point of the generator does not change the potential of the system in any way and it would not be necessary to make any change in lightning arresters where they were properly installed in the beginning. In installing lightning arresters on a three-phase system that was not grounded, the tendency would be, however, to have the lightning arresters set for a higher potential than necessary. G. N. EASTMAN.

Assume that the voltage of this line is 2300 volts. If a ground came on the line the maximum strain across the arresters would be 2300 volts. When the star point has been grounded the maximum strain across the arrester is only $2300 \div 1.73 = 1330$ volts, which is only 58 per cent of what it was in the first case. I should therefore reduce the size of the arrester by about 42 per cent. E. F. LEGGE.

P 43. On a series incandescent circuit, 5000 volts potential, operated from alternating-current transformer, is it possible to use 2000-volt lightning arresters, one between each wire and the ground?

Not if 2100 volts will take the ground on your 2000-volt arrester. FRED B. SHARPE.

Current might follow lightning across and short-circuit lines. Would use two 2000-volt arresters, or preferably an arrester designed especially for series circuits of this character.
RALPH D. LAXTON.

A 2000-volt lightning arrester may be used, provided the line is clear of grounds.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Yes. CLAYTON GEIGER.

It will probably be possible to use 2000-volt lightning arresters, one between each wire and the ground, on 5000-volt series incandescent circuits operated from alternating-current transformers. In case of trouble on the line, however, and especially in the case of the grounding of the line near one of the transformer terminals, the 2000-volt arresters would probably spill over to ground. It would certainly be far preferable in practice to use arresters designed for the operating voltage, as this would avoid a complete breakdown of the circuit when the line becomes grounded on one side. H. H. BARNES, JR.

No. AUGUSTA RY. AND ELEC. CO.

Yes. Use a 2000-volt, double-pole arrester, connected single-pole. M. P. R., N. Y. ED. CO.

No. G. E. PALMER.

P 44. In the case of a 3-phase, 60-cycle system supplying motors, is the liability of reversing phases sufficiently great to warrant the use of reverse-phase relays?

No. H. N. CRANDALL.

Think not. Have had occasion to observe rather closely the operation of several extensive installations of three-phase motors, and have never known or heard of trouble from this cause. RALPH D. LAXTON.

The use of reverse-phase relays would no doubt be advisable where an inexpensive form of relay is available. At present it seems better to have linemen and station men subject to a set of rules for working on three-phase lines by which they will be enabled to do their own testing for phase rotation and thus reduce the liability of reversal to a minimum. H. B. GEAR.

Q

UNDERGROUND LINES

Q 1. Is any town of 10,000 population or under using underground lines?

Manchester, Mass. H. BOTTOMLEY.

Q 2. How can a central station determine, without going into elaborate details, at what time business will justify putting lines underground?

This is rather a matter of local conditions, requirements and judgment in each case. DOUGLASS BURNETT.

In the present state of the art, a company can not determine accurately from a financial standpoint whether or not putting wires underground would be a paying proposition. If, however, the owners of a system are optimistic enough to believe that the business as carried on at present will be still a business at the end of 20 or 30 years, it would pay to put wires underground in the business portion of almost any city of 10,000 or more inhabitants. The cost of maintaining an underground system is so much less than that of an overhead system and the general satisfaction from the use of an underground system is so great, that the matter can not be considered purely from a financial standpoint. F. G. PROUTT.

Tables have been published by the different engineering societies and by the companies manufacturing underground cable and conduits which make it easy to prepare a fairly accurate estimate of the cost of placing lines underground.

The cost of operating underground lines will, in general, be less than that of operating overhead lines, but unless the system is of considerable size, it would be best not to figure on much saving in operation.

The depreciation on underground conduit well installed is very small. Five per cent would probably be a fair figure. The deterioration on cables would be considerably more than on conduit. Eight to ten per cent would probably be fair figures.

W. G. Carlton.

Q 3. What are the advantages and disadvantages of paper-insulated and rubber-insulated cables for underground work on 25-cycle, 6600-volt system?

We have used paper-insulated cable on 6600-volt systems with good results, and find the cable cheaper than rubber-insulated.

United Elec. Lt. Co.

The principle advantage of using paper-insulated cables on underground construction is that of lower first cost, and the principal disadvantage is its liability to crack and break during process of its installation, although this trouble is more liable to occur in smaller cables, such as used for series arc lines, than in larger sizes.

G. Wilbur Hubley.

Q 4. Should periodical insulation tests be made on low-tension underground cables? If so, how often should such tests be made and what method of test should be used? Answer same questions relative to high-tension underground cables, also as to overhead lines.

Insulation tests can not be made on low-tension mains to which house services are connected, for the reason that the test would include the insulation of the house wiring. It is advisable to test feeders and tie lines that can be isolated from other wiring at reasonable intervals. All that is necessary is an insulation test with a portable voltmeter.

Insulation tests on high-tension underground cables, operating at 5000 volts or lower, are of some value in keeping track of the general condition of the cables. It is doubtful if it is worth while to make any elaborate tests on such cables. A test made with an ordinary portable direct-current voltmeter and a battery giving 50 to 100 volts should be satisfactory.

On high-tension lines, operating at pressures above 5000 volts, it is a question whether or not it is worth while to make insulation measurements at short intervals. One company, operating approximately twenty three-conductor, 9000-volt underground cables, in length ranging from one to five miles, made weekly insulation tests with a galvanometer for more than a year. During this time no trouble was located by means of the weekly tests, yet several burn-outs occurred on these lines. If it were possible to make tests at shorter intervals, some good might result from them, or faults in cables might sometime be detected by weekly tests. It is, as a rule, a great deal of bother to get lines for test, and there is a certain element of danger for the men doing the testing. For these reasons it is doubtful if it is worth while to make insulation tests on high-tension lines at short intervals.

These reasons also apply to overhead high-tension cables and there is the further difficulty that insulation tests on overhead cables depend very largely on the condition of the weather.

W. G. Carlton.

Q 5. What guarantees are demanded of the manufacturer on low-tension cable for underground circuits as to thickness and quality of insulation? As to conductivity? As to thickness and quality of lead? Answer same questions relative to high-tension underground cables.

The best guarantee to obtain from a manufacturer of underground cable is a test of all cable after it is installed in the ducts at some reasonable test pressure, depending, of course, on the use to which the cable is to be put; also a guarantee from the manufacturers for a period of five years or more from the date test is completed. The thickness of lead and insulation would vary with the various sizes of cables required, but the purchaser should lean rather to both heavy lead and heavy insulation than to have either comparatively light.

F. G. Proutt.

It is generally better, particularly for a small company, to leave the specifications for underground cable, both for low and high-tension work, to the manufacturers. Comparisons, however, should be made between the thicknesses of the paper and lead walls that the different manufacturers propose to furnish.

W. G. Carlton.

Q 6. Will some of the companies who have used paper insulated lead-encased cable on 8000-volt series-arc circuits, including loops up the lamp pole, give their results with same?

We are using paper-insulated cables on arc circuits, and they give very good satisfaction. HERBERT E. BRAGDON.

Paper cable, lead-covered, is used very successfully on 8000-volt arc circuits. The lead sheath should be grounded at intervals to decrease the electrolysis. It must be handled very carefully, so that the sheath is not punctured, as this would result in moisture gathering, which would destroy the insulation. H. J. MEYER.

With seven-thirty-second-inch insulation, frequent punctures occur after cable has been in use seven to nine years. Some of the trouble, however, is due to electrolysis; almost no trouble with sections of cable running up the poles.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Q 7. How does the cost of maintenance of underground lines compare with that of overhead lines?

In general the cost of maintenance of underground lines is very much less than that of overhead lines. In case of a bad burn-out the repairs will, however, be much higher than on overhead work. W. G. CARLTON.

Q 8. What current-carrying capacity per 1000 circular mils should be allowed in underground feeders?

The current-carrying capacity of underground feeders (or mains) should be such that the maximum load would not cause an excessive rise in temperature, but would stand large overload for a short time.

Allowing a maximum rise in temperature at 50 degrees centigrade, the amperage per 1000 circular mils would be:

Sizes of Feeders, Circular Mils	Amperage per 1000 Circular Mils
1,500,000	0.9
1,000,000	1.0
750,000	1.1
500,000	1.2
350,000	1.5

In concentric feeders the current should be about five per cent less. G. M. ARMBRUST.

One ampere per 1000 circular mils is a fair rating for intermittent duty; that is, during the ordinary peak load up to three hours. For continuous duty, 0.75 ampere is safer and better for the cable.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

One ampere per 1000 circular mils is carrying capacity allowed on underground feeders. H. J. MEYER.

Q 9. What has been the experience of those operating paper and lead cables under water? Is not the trouble from electrolysis likely to be less, and, therefore, the life of the cable longer, than when installed in the ordinary manner?

Cables give almost no trouble under water. No trouble from electrolysis except where cables enter and leave the water, and that is obviated by bonding and installing some bare conductors at that point to take care of the foreign currents.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Q 10. What protection can be given lead covering of underground cables from ground currents?

Well bonded together and connected to good ground wire, has given good service. HERBERT E. BRAGDON.

Ground the lead sheathing of cables in every manhole.

G. WILBUR HUBLEY.

Insulate cables from ground in manholes and break the sheaths frequently, inserting insulating joints at those points.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

The lead covering of underground cables can be prevented from carrying stray currents if the lead sheath is broken at reasonable intervals and some kind of insulating joint installed across the break in the lead sheath. With lead cable installed in tile ducts there is not much danger of any large amount of stray current reaching the cable, except in manholes where iron brackets are used. It is not good practice to install a number of lead-covered electric light or power cables on a common iron support. In the case of important cables, particularly high-voltage cables carrying large amounts of power, it is desirable to cover the cable through the manhole with vitrified clay tile. If tile conduit is used, there should be little danger of stray currents affecting the cable when protected in manholes in the above manner. W. G. CARLTON.

Q 11. What kind of duct and what kind of insulation is best for underground lines?

Fibre conduit. FRED B. SHARPE.

Multiple terra-cotta duct; chiefly on account of durability. L. CARSPECKEN.

In selecting a conduit for underground lines there are several requirements that should be kept in mind.

(1) The ducts should be practicably indestructible, not subject to disintegration from the elements, water, acids, alkalies, *et cætera,* or to electrolysis.

(2) The ducts should have a smooth inside surface to permit of drawing in cable easily, should be reasonable in cost and economical to install.

Many forms of conduit have been in use, as wooden pump log, cement pipe, iron pipe, *et cætera,* all subject to more or less objections. The duct found to be the most satisfactory is vitrified clay tile.

These ducts are made in various sections and lengths, those most commonly used being the single round and the single square tile, about three and one-half inches in diameter and one and one-half feet long. Multiple conduit is made in two, three, four, six and nine-duct sections, and three feet long.

The single duct is most available for use in crowded streets where groups of pipes have to be crossed or where it is necessary to go between pipes. This style of conduit also has the advantage of two walls separating any two cables, and every vertical joint being broken protection is afforded for the cables in case of a burn-out.

Multiple conduit may be used in streets free from obstructions in outlying districts. G. B. SPRINGER.

Q 12. Do you build conduit with your own men, or do you have it done by contract? Which method do you consider cheaper, and how much?

For the past three years we have made contracts for all our underground work and find that we can get it done cheaper in that way than we could do it ourselves. We have constructed about five miles of conduits every summer in this manner.

UNITED ELEC. LT. CO.

With our own men, 25 per cent cheaper and better than by contract six years ago; have had it done by contract since then.

L. CARSPECKEN.

Whenever possible conduit lines should be built by the regular employees of a company. After a conduit system has once been put in operation, the extensions to it are continuous and it would be a poor proposition to have to hire a regular conduit contractor to put in the extensions as they were required. With the original installation, if the company has men who can handle the work it will be all right for them to install it; if, however, it has not such men but would have to educate them at the company's expense, it would be much better to put in the first installation by contract. F. G. PROUTT.

Q 13. Has any one had any experience with tile conduit broken either from water freezing in the ducts or from water absorbed by the tile freezing and cracking same?

We have seen tile conduit heaved out of line by frost. This happened when it was laid too near the surface in a grass strip between curb and sidewalk. We do not think it would have heaved had it been laid deeper or been underneath a waterproof pavement. This was not our conduit. We make it a positive rule to drain all our manholes to the sewers.

We do not think a tile that will absorb water is fit for conduit construction. UNDERGROUND DEPARTMENT,
THE EDISON ILL'G CO. OF DETROIT.

Q 14. In laying multiple conduit it is the custom of some companies to use a layer of concrete about three inches in thickness on the bottom and top of conduit, omitting it entirely from the sides. Has any one had experience with conduits so laid being interfered with or broken by men of other companies working around it? Has this method been found to be poor or good economy?

Find it best to surround subway with three inches of concrete for protection against digging by other companies, and also to render subway more nearly watertight on account of the imperfect joint of multiple-duct conduit. L. CARSPECKEN.

Q 15. How is the leakage of illuminating gas into subway manholes prevented or checked?

Manholes connected through trap sewer and well ventilated by open cover. HERBERT E. BRAGDON.

It is difficult to prevent gas accumulating in manholes if there is a considerable leakage from gas pipes. Where there is any great amount of gas, ventilated manhole covers should be used. The gas companies should also be notified, so that their pipes can be repaired. Where there is thought to be gas in manholes they should be ventilated by leaving the cover off as long as necessary before men are allowed to work in the hole. Tests should also be made with a lighted match or piece of paper before sending men into a manhole to work if it is necessary for them to use a torch or other flame in the manhole. Where it is not possible to get rid of the gas in the manhole a soldering pot or iron should be used instead of a torch, the flame being kept out of the manhole. W. G. CARLTON.

It is a very difficult matter to prevent gas from finding its way into subway manholes; the only preventive means is to have all points in gas mains in the vicinity of manhole calked as often as possible. For this purpose gas companies generally have a gang of men follow all openings made in the streets by various companies, and calk all exposed joints.

All manholes larger than four feet square should have ventilated iron covers. A style commonly used has 32 holes, one and a quarter inches in diameter. These allow the gas to escape in most cases. G. B. Springer.

Q 16. What is the best method of preventing explosions in manholes from the combination of illuminating gas and air, as well as mixtures of other gases and air?

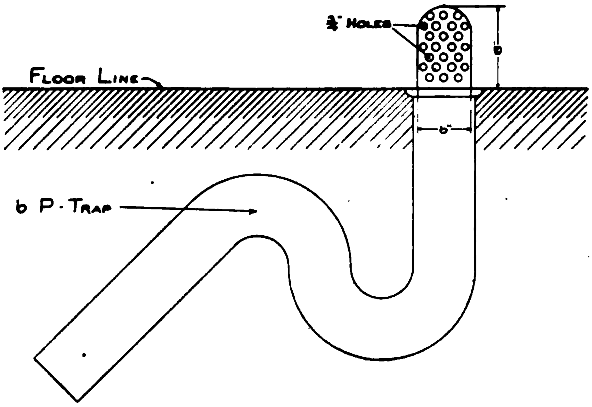
See answer to question Q 15. Herbert E. Bragdon.

The best method of preventing explosions in manholes is to ventilate the manholes. F. G. Proutt.

All manholes in the vicinity of gas mains should be uncovered and aired out for at least ten or fifteen minutes before using a light of any description, and if there is the least smell of gas remaining a lighted newspaper or a piece of waste should be thrown into the hole. This method of testing manholes may cause a blow-up, but it may also save lives.

G. B. Springer.

A perforated lid on manholes and service boxes, with a daily inspection for gas leaks; the latter to be at once reported to gas



company. This, with air circulating through pipes carrying cables has made explosions very rare. In sewering manholes we found the ordinary bell trap, or flat grating on P-trap, would clog quite often in heavy rains. Have adopted an inlet of cast iron, as per sketch, and have no further trouble on account of clogging.
L. Carspecken.

Q 17. Would it be a desirable adjunct in a transformer manhole to have a ventilating tube run from the bottom of the manhole to the open air, or do the pipes carrying the cables provide sufficient circulation of air?

I think it advisable where circumstances will permit. The pipes are not good ventilators as they are well filled with cable.
Herbert E. Bragdon.

A ventilating tube would be of great advantage in manholes where transformers are installed, and should be installed wherever possible. Two tubes should be installed in each case, however, one from the bottom of the manhole and one from the top, so as to provide good circulation.
The Edison Elec. Ill'g Co. of Boston.

It is desirable to ventilate all manholes in which transformers are located, either by having holes in manhole cover or by running a pipe from near the top of the manhole under the street to the sidewalk and bringing it up through the sidewalk in the shape of a small cast-iron post.
F. G. Proutt.

This would depend on the amount of heat given off by the transformer. In the case of a large transformer heavily loaded it would be desirable to provide as much ventilation as possible. The ventilated cover on the manhole would probably be more satisfactory than a tube.
W. G. Carlton.

Q 18. Is any feeder cable safe (in large high-tension systems) that will not stand test of double voltage for one minute?

No.
Ralph D. Laxton.

In my opinion a high-tension cable is not safe unless it will stand a double-voltage test for one minute. H. J. GILLE.

It should not be necessary to test feeder cables for large high-tension systems at double the normal voltage. In one system operating at 9000 volts and having about 100 miles of cable installed, cables are tested when installed at 50 per cent above the normal voltage for a period of one minute, and similar tests are made semi-annually on all cables. Few cases of line trouble have occurred, and it is believed that the oil switches on the lines will protect the stations or substations from any line trouble. During a period covering two years' time no cables have been broken down on the semi-annual test, although occasionally when a cable is first put in service it will break down on the preliminary test. W. G. CARLTON.

It seems to me that it ought to be self-evident that an underground cable that will not stand the tests stated is decidedly improper. N. T. WILCOX.

No. A. BALSLEY.

Q 19. What is the reason for the slow introduction of high-tension underground cables, above 13,000 volts?

Difficulty in securing thoroughly reliable insulation.
RALPH D. LAXTON.

Q 20. Is the installation of static discharge gaps at both ends of all feeders of a high-tension underground system compatible with safe operation?

Yes, if resistances between discharge gaps and ground are sufficiently high to prevent maintenance of arc at line potential.
RALPH D. LAXTON.

It should be, under any ordinary conditions.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

Q 21. What method of construction will stop leaking of compound out of paper and lead-covered cables where the end of cable, sweated into the lug, is the lowest point in cable run?

The only method is to use a special dry cable; that is to say, a cable of which the paper insulation is saturated but has no excess of oil. It would not be good practice to use such a dry cable for general purposes, but special lengths of it might be used for station terminals where the trouble referred to occurs.

UNDERGROUND DEPARTMENT,
THE EDISON ILL'G CO. OF DETROIT.

Q 22. What is the cause of bubbles rising in compound of terminal bells in 13,000-volt paper and lead-covered cable transmission lines after same have been in service some time?

In some cases this has been found due to hydrostatic head in considerable length of the cable at higher elevation than terminal bell. In other cases the explanation has been offered that bubbles were caused by heating of cable expelling air.

P. JUNKERSFELD.

Q 23. In an underground 3-wire 110-220-volt direct-current distributing system, is a bare stranded cable satisfactory for neutral conductor?

Quite so. DOUGLASS BURNETT.

I see no reason why a bare stranded cable can not be operated satisfactorily on an underground three-wire system with neutral ground; in fact, I think this is a positive advantage.

N. T. WILCOX.

A bare stranded cable is entirely satisfactory for the neutral wire in underground three-wire system. F. G. PROUTT.

In two cases that came under the writer's notice a great deal of trouble was experienced with bare neutral used in connection with three-wire underground lighting distribution.

The first system was fed from a station supplying both lights and ground-return railway system. In the second system the light and railway plants were separate, but the underground mains short-circuited a loop of track carrying heavy return currents. Both installations were in a damp, acid soil, saturated at intervals by underground springs, and the lighting neutral was found to be carrying a considerable volume of the railway return current. M. CARRINGTON.

A bare-copper cable is satisfactory for the neutral of a low-tension system. It is not, however, good practice to pull in lead-covered cable in the same duct with a bare-copper cable, since the lead covering will carry neutral current and may become damaged. W. G. CARLTON.

The bare cable should be satisfactory in almost every case. M. A. HOGAN.

Yes, if railroad return currents are not to be encountered; if they are an insulated cable should be used.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

Q 24. What are the lowest figures on record of the annual cost per mile of maintaining underground lines under ordinary conditions?

Q 25. In a moderate-sized system, direct-current, 3-wire, 110-220 volts, about 2000 kilowatts, it is suggested to operate from the station 'bus all feeders running to a distance of 1000 feet or under. Pressure wires determine the rate of rise of 'bus e.m.f. at time of maximum load. Beyond this distance feeders are regulated by motor-driven boosters, latter series wound. How does this check up with modern practice in regulation?

A better way would be to install from two to three 'busses in the station, feeding one straight from the generators, and the others through boosters. This will allow throwing over of circuits to obtain the minimum voltage variation as the loads shift. If double-throw switches are provided on the generator panel it may be possible to cut-out one booster, or at least hold it as a spare, operating both high and low 'busses direct from the separate generators, when the load is heavy enough to justify it. M. CARRINGTON.

In a station of 2000-kw capacity, distributing direct current, more than one 'bus should be operated, unless a large share of the load is concentrated at points uniformly distant from the station. In case of long feeders boosters may be necessary, but their use should be avoided if possible. W. G. CARLTON.

In general, the method described is standard practice with Edison companies, except in the use of boosters. Some companies use boosters for long feeders that require extreme pressures, but effort is generally made to proportion the feeder copper so that by running two or more 'bus pressures at the station, it is possible to maintain a satisfactory average pressure. If a battery is available several 'bus pressures can be obtained to meet irregular pressure conditions, without the use of boosters.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Q 26. Are there any factors, except the resistance, that would cause an observable loss of energy or watts on a 25-cycle, 3-phase transmission line about 7 miles long, one-half of which is paper-lead 3-conductor cable and one-half overhead, operating at or under 15,000 volts, and at any power factor, including unity? If so, enumerate same and give formula for their determination?

See pages 103-126 Foster's *Electrical Engineers' Pocket Book.* W. G. CARLTON.

Currents set up by mutual induction (eddy currents or their equivalent) and dielectric hysteresis might each come in to cause some considerable losses, and perhaps other features might also come in, depending upon the surroundings of the installation. The formula by which the magnitude of these losses may be calculated may be found in their general formula in many text-books, but the specific formula applying to the case that may be referred to can not be given without knowing full details. and the chances are that the conditions are so complex that the losses can not be accurately computed but can only be approximated by computation and the application of judgment.

DUGALD C. JACKSON.

Q 27. What is the best roof or top (not cover) for manholes containing subway transformers and designed with a view to keeping water from penetrating during spring thaws and heavy rains?

A good concrete top for manholes will be practically waterproof. Cracks are likely to develop in manhole walls, particularly in the corner between the side walls and the roof. These should be kept cemented up. W. G. CARLTON.

Probably the best roof for manholes is concrete. In laying concrete roofs a layer of cement mortar about one inch in thickness should be spread on the temporary boards for supporting the roof during construction, the concrete, about eight or nine inches thick, being laid on this and well tamped. On top of the concrete another inch of fairly rich cement mortar may be spread. This method will make the roof practically watertight. If deemed necessary, a coating of tar could be added, but this would probably be done only in exceptional cases.

G. B. SPRINGER.

R

TRANSFORMERS

R 1. What has been the average life of lighting transformers?

Fifteen years. C. W. KOINER.

Under present design of transformers the average life should not be less than ten to fifteen years when operated under normal conditions of service. G. WILBUR HUBLEY.

Our experience has been that with air-cooled types ten years is the maximum time that they should be used. Some of the older oil-cooled types have reached the limit of useful life in the same time. High-grade modern oil transformers should exceed that time by a considerable period.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Varies greatly with different makes. About eight years for best one built ten to twelve years ago. Will probably reach fifteen years for more modern types. M. P. R., N. Y. Ed. Co.

R 2. Which is the better type of transformer to use, core or shell, for motor service? For lighting service?

Shell type where there is an inductive load of any proportion; core type where there is a large lighting load or where subject to severe electrical storms. A. E. Walden.

Both types have their advocates. Shell type will operate at a lower temperature. C. W. Koiner.

Core type is probably preferable for all service, as it has fully as good characteristics and its form tends to a higher factor of safety in insulation between high and low tension.
W. H. C.

Shell-type transformers are desirable for either light or power service. Core type are especially adapted for lighting service only. G. Wilbur Hubley.

There is really no choice of type of transformer for either motor or lighting service. From central-station view, the value of a transformer is measured by the first cost, reliability of operation and characteristics. Both types can be built, and are built, with the same characteristics, same efficiency and same reliability of operation, and the choice of type shifts down to the ability of the manufacturer to produce a properly-built device.

The shell-type transformer generally has the advantage over the core type, in that it naturally adapts itself to a construction that gives a lower impedance voltage, and therefore better regulation with inductive loads; each type having approximately the same core and copper losses. E. A. Wagner.

Shell type has a very slight advantage in regulation. Core type is much preferable from the more important standpoint of insulation. M. P. R., N. Y. Ed. Co.

R 3. Will a meter-current transformer always maintain its calibration if operated within its rated capacity?

Yes. J. F. DOSTAL.

Yes; approximately so. G. WILBUR HUBLEY.

Yes. THOMAS S. RICHARDSON.

R 4. What is good practice in the way of inspection of transformer for insulation, leakage and weakness?

Test transformers for leakage and insulation at regular intervals. G. WILBUR HUBLEY.

Transformers ought to be given a test for insulation resistance and disruptive strength of insulation that is not less searching than the standard recommended by the American Institute of Electrical Engineers. A report upon the subject may be found in volume 19 of the Transactions of the American Institute of Electrical Engineers. On pages 1084 and 1085 of that volume will be found the matter particularly inquired about. A pamphlet copy of the report can probably be obtained from Mr. Ralph W. Pope, secretary, 95 Liberty street, New York city.

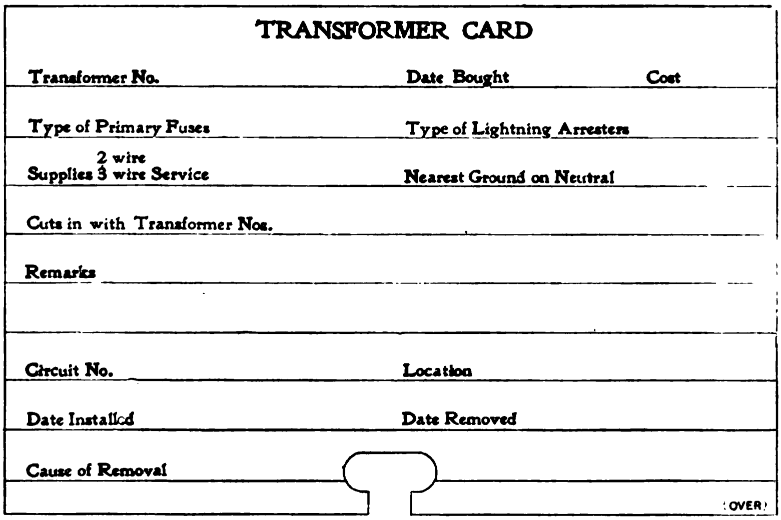
By "leakage" the inquirer probably means the magnetizing current of the transformer. This should be quite small, but it is of much less importance than the losses of energy due to hysteresis and eddy currents, which contribute to the exciting current. These should be measured by a wattmeter in the simple manner that has been made known through various publications.

DUGALD C. JACKSON.

R 5. (a) Do you test transformers before placing them on the line and at intervals after they have been in service? (b) How are the records of such tests kept?

(a) Yes, both an insulation and loss test. These tests are made upon every set and removal, but not while in service. (b) For samples of records see answer to question X 4, by H. S. Russell. C. F. HAYWOOD.

We test all new transformers and keep record of tests on card shown herewith. Whenever a transformer is changed for any cause a similar test is made on it, but we do not make any attempt to test all transformers at regular intervals.



TRANSFORMER CARD

Transformer No. Date Bought Cost

Type of Primary Fuses Type of Lightning Arresters

Supplies 2 wire / 3 wire Service Nearest Ground on Neutral

Cuts in with Transformer Nos.

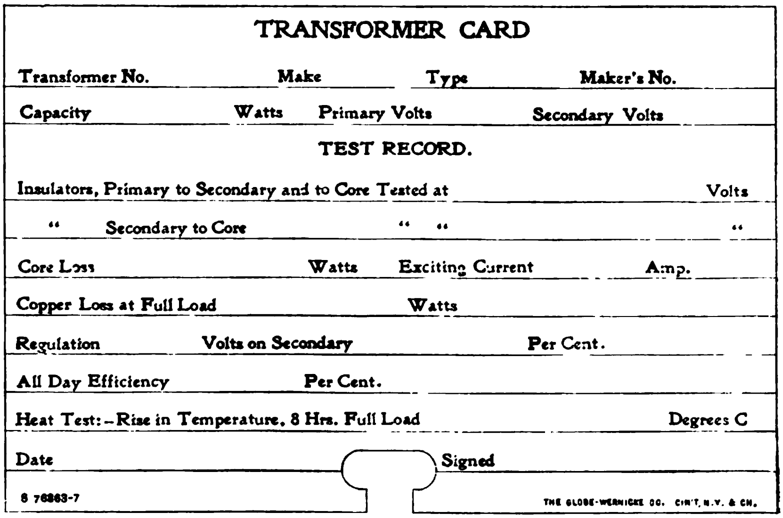
Remarks

Circuit No. Location

Date Installed Date Removed

Cause of Removal

(OVER)



TRANSFORMER CARD

Transformer No. Make Type Maker's No.

Capacity Watts Primary Volts Secondary Volts

TEST RECORD.

Insulators, Primary to Secondary and to Core Tested at Volts

" Secondary to Core " " "

Core Loss Watts Exciting Current Amp.

Copper Loss at Full Load Watts

Regulation Volts on Secondary Per Cent.

All Day Efficiency Per Cent.

Heat Test:—Rise in Temperature, 8 Hrs. Full Load Degrees C

Date Signed

8 76863-7

THE GLOBE-WERNICKE CO. CIN'T, N.Y. & CH.

S. R. Inch.

(a) Yes; in all cases. (b) The records of each test are properly recorded from time to time and kept on file.

G. WILBUR HUBLEY.

Tested before installation and each time they are brought to station when making changes. Do not find it necessary to test on the line. (Overhead lines and grounded secondaries.)

M. P. R., N. Y. ED. Co.

R 6. What is the liability of puncturing the insulation between the primary and secondary coils of a meter-current transformer by opening the secondary circuit with a full load on the primary?

The secondary coils of a current transformer should never be opened, for when opening the secondary the voltage rises to overcome the resistance and is liable to puncture the insulation.

H. N. CRANDALL.

Very great. The potential across the open secondary of a 500-watt transformer, measured by a static voltmeter, was 4500 volts.

C. F. HAYWOOD.

There is danger of puncturing insulation between adjacent layers of either the primary or secondary, but no especial danger of puncturing between primary and secondary.

M. P. R., N. Y. ED. Co.

R 7. (a) Is it good practice to use transformers of different sizes on an interconnected secondary system, and how should they be fused? (b) How should individual transformers be fused?

(a) We have found it quite satisfactory, but try to get the larger transformers together as much as possible. (b) We fuse to the capacity of each transformer. We also fuse our secondaries and branches.

L. E. WATSON.

We do not consider it exactly good practice to bank transformers of various capacities on an interconnected secondary system, but rather to select those of uniform capacity and type, using in the outside secondary leads of transformers fuses of 100 per cent overload capacity. W. P. HAZELTINE.

(a) Yes. (b) Each transformer should be fused for its respective capacity.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

(a) Transformers should not be fused on an interconnected secondary system. (b) Individual transformers should be fused on the primary and tied in solidly on the secondary mains.

W. T. M., N. Y. ED. CO.

(a) It is not good practice unless all the transformers have exactly the same regulation, which is seldom the case. (b) With either banked or separate transformers, fuse primary side only, using fuses one and a half to two times the capacity of the transformers. M. P. R., N. Y. ED. CO.

It is better to have them all of the same size.

C. W. KOINER.

Can not be considered as the best practice, as the per cent regulation is not always proportional to the capacity, and those of the best regulation will take more than the proper share of the load. W. H. C.

(a) No. (b) Fuse primaries for 10 per cent more than rated output in watts divided by primary voltage.

FRED B. SHARPE.

(a) It is not good practice to interconnect secondaries of transformers of different sizes.

(b) Fuse all transformers with fuse rated at the amount of primary current they will take at full load, or perhaps a little over—say 10 or 15 per cent. H. N. CRANDALL.

(a) Transformers must be of one size and preferably of one make.

(b) Fuse for 15 per cent overload. D. CLINTON SHAIN.

It is not good practice to use different sized transformers on interconnected secondaries, as the smaller would suffer from overload, especially in the event of mishap to any of the larger ones. Where all transformers are of equal capacity it is best to fuse primaries for 50 or 75 per cent overload.

CHAS. H. PETERS.

It is better to use interconnected transformers of the same make and also of the same size, though at the ends of the network smaller ones may be used which will keep up the pressure at those points.

We connect the transformers solid to the secondary three wires and fuse only the outside wires between transformers. We inspect all primary fuses after every electrical storm.

A. R. MACKINNON.

(a) Yes. Primaries fused to 200 per cent load. Secondaries not fused except by junction fuses half-way between transformers.

(b) Individuals should have primaries fused to 200 per cent load, secondaries not fused. C. F. HAYWOOD.

Yes. For lighting loads transformers can be fused for 100 per cent overload. J. F. DOSTAL.

It is best practice to maintain the same types and similar sizes of transformers on respective sections of interconnected secondary system. G. WILBUR HUBLEY.

(a) Large numbers of such transformers are used in this way with perfect results. Transformers are fused on primary side only for 100 per cent overload, and in proportion to their size. (b) Individual transformers fused for 100 per cent overload is good practice.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

It is better to limit a 'bus line to a single transformer, as trouble on one transformer out of several, causing it to burn out or fuses to blow, will throw an excessive load on the other transformers, thus increasing the tendency for the service to be interrupted, whereas with the single transformer only the individual 'bus-line service will be interrupted.

DOUGLASS BURNETT.

R 8. (a) How should the sizes of transformers and secondary mains be determined? (b) What are the limits of economy in substituting large transformers for smaller ones?

(a) The size of transformers and mains should be determined by the density of the load. As few sizes should be used as possible. One size wire, either No. 6 or No. 4, can be used for practically all residence districts, and two or three sizes, say No. 2, No. 0, No. 0000, for business districts. (b) Size of transformers should be about in proportion to size of wire, say, 3 to 5-kw on No. 6 and 25 to 50-kw on No. 0000, the distance between transformers depending on the density of load.

THE SEATTLE ELEC. CO.

The sizes of transformers and secondary mains can be determined from the nature of the business. If in a residence section a smaller transformer per kilowatt would be required than in a business section, also smaller mains, provided the load is metered.

D. CLINTON SHAIN.

R 9. Is it good practice to bank transformers in other than very thickly settled districts; for example, in a district four blocks square, supplying 50 customers?

Should not say it was good practice to use a bank of transformers unless the load was so great as to go beyond the capacity of the largest transformer that could be bought. We are using for pole work transformers of 100 kilowatts with good results. Some of these transformers have been in use for six years supplying Edison three-wire system without any attention whatever.

JAS. B. FOOTE.

No. FRED B. SHARPE.

It depends entirely upon local conditions.

D. CLINTON SHAIN.

No; it is not good practice to bank transformers. In such case it would be better to connect them separately if possible.

LEE JERNIGAN.

Yes, if proper distribution of secondaries is maintained.

G. WILBUR HUBLEY.

A district four blocks square containing fifty customers is a very favorable density of load for secondary network system.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

It is generally better practice not to bank transformers, but each transformer should feed as many customers as is consistent with good regulation and economy of construction and operation. M. P. R., N. Y. ED. CO.

The investment necessary for the various methods of installation should be studied for such a case, and the one chosen which after all factors are considered will give the largest return for the money invested and the nature of the load and number of customers, must in most cases be the controlling factor.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

R 10. (a) How much transformer capacity should be allowed for satisfactory motor service? (b) Should lights and power be served from the same transformer?

(a) Transformer capacity equal in amount to rated motor load should be provided. (b) Lights may be served from the same transformer as motors, provided the motor load is a fairly steady one, such as factory or shop work.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

(a) Allow one kilowatt of transformers to one horse-power of motors except for elevator and other variable-speed motors, for which it is generally advisable to install larger transformers. (b) Lights and motors may be run from same transformers if largest motor is not more than half of transformer capacity and motors are not started oftener than twice a day.

M. P. R., N. Y. Ed. Co.

(a) One kilowatt per horse-power installed is very satisfactory for motor service. (b) Lights are very satisfactorily supplied from same transformer as power if the transformer has good regulation on inductive loads.

The Edison Elec. Ill'g Co. of Boston.

Oudin *Standard Polyphase Apparatus and Systems,* fourth edition, 1904, page 86: "This means that the transformer, supplying current to induction motors of average sizes, must have a capacity of one kilowatt for every horse-power output of the motors." See also, *Foster's Hand Book,* third edition, 1904, page 127, to the same effect. Alex. J. Campbell.

Transformers should be of one-kilowatt for each horse-power of the motor. C. W. Koiner.

(a) One thousand watts per horse-power. (b) No.

F. C. S., Malden Elec. Co.

(a) Not less than one-kilowatt and in some cases as high as 1.5-kw for individual sets for one-hp motors. (b) Should consider it safe to put motors on lighting transformers if starting current of motors does not exceed 50 per cent of capacity of transformers connected; otherwise not. W. H. C.

(a) One kilowatt per horse-power connected.

(b) Yes, if secondaries are of ample size and regulation is good. D. Clinton Shain.

(a) One kilowatt of transformer capacity per horse-power.

(b) Lights and power from the same transformer is common practice and very satisfactory. H. J. Meyer.

(a) One-kilowatt transformer capacity should be allowed for each horse-power of motor in use. (b) Ordinarily there is no objection to the use of lights from the same transformer.

A. R. MacKinnon.

For alternating-current single-phase motors, install transformers double the capacity of the motors connected. If motor load is but a small percentage of the lighting load connected, or if former is used only in the daytime, the same transformer can serve both; otherwise set a separate transformer for the motor. WARREN PARTRIDGE.

This depends on power factor, but ordinarily one-kilowatt transformer capacity should be installed per horse-power of motor installation. Separate transformers should be employed to serve lighting circuits. G. WILBUR HUBLEY.

Light and power may be served from the same transformer when the conditions of power service are such as not to interfere with lighting regulation. Allow single-phase motors up to five horse-power. DOUGLASS BURNETT.

R 11. On a three-wire secondary line, 110-220 volts, 3000 feet long, there are two transformers of 30 kilowatts each, located respectively 750 feet from either end of the secondary line. Both transformers are supplied with current from the same primary circuit. The maximum load at any one time is very close to 1500 16-candle-power lamps. The proportion of this load located on either side of a point half way between the two transformers at any time does not exceed 60 per cent of the total load of the entire secondary circuit. Is it better to operate these two transformers in multiple on a continuous secondary circuit, or is it better practice to cut the secondary circuit at a point half way between the two transformers and operate the secondary as two separate circuits, each one fed by one of the above-mentioned transformers?

Better cut the secondary and let each transformer carry its own load. M. P. R., N. Y. ED. CO.

Very little difference as to economy of operation in the two methods, but a considerable difference as to reliability and quality of service.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

Use a continuous secondary circuit with the two transformers in multiple. J. F. DOSTAL.

If the secondary circuit were cut the danger of all the load being thrown on one transformer, blowing its fuses and putting the entire street in darkness, would be done away with. Again, if the two are connected in multiple and fuses blow, the primary circuit must be cut off to enable transformers to be re-fused, whereas if circuits are separate this is not necessary. I should say in this case, cut the circuit. A. PETERS.

It would be better to operate the two connected. In the event of one breaking down the other would serve to supply the customer while repairs are being made, and the number of lights used could be decreased to prevent overload. C. W. KOINER.

Best to keep the two transformers on the continuous secondary circuit. G. H. CUSHMAN.

The fact that a load of 1500 16-cp lamps is supplied from two 30-kw transformers, shows these transformers to be about 40 per cent overloaded at maximum. Under such conditions, it would be extremely difficult to adjust primary voltage on this circuit so as not to run over voltage into nearby transformers, which might not be running on overload, and thereby straining lamps connected with them. As it is next to impossible to get anything like uniform voltage on individual secondaries fed from same primary, by all means connect secondaries together, but have transformers of similar capacity, and be sure that primaries and secondaries are so connected as not to create opposition. CHAS. H. PETERS.

Should connect the transformers in multiple to the secondaries so that the lightly-loaded end of transformer could help cut the other. A. R. MACKINNON.

Under conditions noted should consider it better practice to cut secondary circuit and operate as two separate and independent circuits. G. WILBUR HUBLEY.

Operate the 'bus line as two separate circuits.
DOUGLASS BURNETT.

R 12. What amount of overloading of transformers on peak load will give the best all-day efficiency? What per cent overload is safe or economical?

Do not consider that overloading transformer is desirable from the standpoint of regulation. Most complaints of low voltage in houses are of service during peak hours. W. H. C.

Twenty-five per cent. C. W. KOINER.

About 75 per cent. G. H. CUSHMAN.

Transformers up to 20-kw sizes can safely be carried on a 20 per cent overload during the peak of the load in summer and from 30 to 40 per cent overload in winter. J. F. DOSTAL.

Should not exceed 50 per cent overloading on transformers for period of peak load if time does not exceed half hour; if longer period, should limit overloading to 25 per cent.
G. WILBUR HUBLEY.

We consider 50 per cent overload on peak as reasonably safe. THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Thirty to 40 per cent overload at peak will not injure a good transformer, and this condition gives about the best all-day efficiency. M. P. R., N. Y. ED. CO.

For short peak-load periods, one to two hours, 50 per cent overload is safe and is the maximum overloading that should be allowed for economical operation.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

R 13. What reasons have led to the recent increase in insulation in transformers? This has been noticed particularly in 10-kw apparatus.

In all probability increased insulation is the outcome of grounding transformer secondaries. It is evident that if transformers with grounded secondaries are active during severe lightning storms, and primaries become affected, there is every inducement for a static discharge between primary and secondary windings at their commencement, which, being followed by current, would soon break down the best insulation.

CHAS. H. PETERS.

There are two reasons why I think there is a tendency to increase the insulation between primary and secondary of a transformer:

First—For public safety.

Second—For life of transformer. E. F. LEGGE.

R 14. Do we not pay too much for high efficiency in the transformer and would not a slight increase in the power loss effect a great saving in first cost and interest?

At a bare production cost of 1.5 cents per kilowatt-hour, a change of one per cent in the loss of a 1000-watt transformer amounts to $1.31 per annum, which at a 15 per cent interest and depreciation charge is equivalent to an investment of $8.74. In other words, for every tenth of one per cent gain in transformer efficiency, we can afford to pay an additional first cost of 87.4 cents per kilowatt capacity. WARREN PARTRIDGE.

This is a question dependent entirely upon local conditions, cost of fuel, *et cætera*. J. WILBUR HUBLEY.

As the construction of transformers is purely a technical proposition from the standpoint of efficiency and as engineers are always striving for the best, it would be a bad idea for the customer to be satisfied with anything but the best, and the actual cost of construction of transformers slightly lower in efficiency than the best now offered would be little different from those at present on the market. F. G. PROUTT.

Determine the reply in the same way that you would the cost and efficiency of station machinery for your steady load *versus* your peak load. The highest efficiency is required, and the greatest cost warranted, in the transformers that handle a steady load. DOUGLASS BURNETT.

R 15. Are transformers as efficient when wound for 6000 to 16,000 alternations without changing the primary connections as transformers that are wound for one frequency only?

Generally, transformers built for low frequency are more efficient when operated on a higher frequency, and the contrary is true with transformers built for high frequency on low-frequency systems. W. H. C.

Transformers are more efficient when wound for the frequency at which they are to be operated. H. N. CRANDALL.

No. HARRY M. HOPE.

More efficient when designed for one frequency only.
G. WILBUR HUBLEY.

R 16. In changing over an 1100-volt, single-phase system to 2200 volts, is it practical, safe and economical to take two transformers of the same size and type, connect the primaries of the two in series and parallel the secondaries?

In changing from the 1100-volt system to 2200 volts, it would probably, for several reasons, figure out a good investment to scrap or trade the old transformers, replacing same with those of a larger and more modern type. With some of the older types, it would not be possible to successfully connect two 1100-volt transformers in series across 2200-volt lines, to operate on a three-wire secondary system, which it would appear advisable to install in connection with above-noted change of transformers.
W. P. HAZELTINE.

No. F. C. S., MALDEN ELEC. CO.

It is not economical to use two transformers where one will do and it is done only where transformers are too good to discard when such changes are made. C. W. KOINER.

It is feasible, probably safe, but not efficient or in line with good practice. W. H. C.

You will be perfectly safe in adopting this arrangement.
A. PETERS.

Yes. FRED B. SHARPE.

It is safe to connect two 1100-volt transformers with primaries in series on 2200-volt circuit, but is not practical or economical when the cost of the transformers is considered.
H. N. CRANDALL.

Yes, it is quite practical to connect the two transformer primaries in series and their secondaries in parallel, provided secondaries are connected in proper order; but it must be remembered that old transformers are seldom economical to use.
CHAS. H. PETERS.

Yes; it is safe to take two 1100-volt transformers and connect their primaries in series and their secondaries in parallel, and use them on a 2200-volt primary. It is often practiced.
LEE JERNIGAN.

It is practical and safe, but not economical.
G. H. CUSHMAN.

It is entirely practical and economical, and we consider it safe, as they will be operating only on their rated voltages. However, the transformer losses will be greater than with one transformer. A. R. MACKINNON.

This has been done in emergencies, or as a sort of makeshift, but such a system will have heavy core losses.
J. F. DOSTAL.

It is practical, but not economical or desirable as a permanent proposition. G. WILBUR HUBLEY.

In view of the generous allowances the manufacturers usually made for old transformers, we would suggest, in the case mentioned, exchanging the old transformers for new ones of 2200-volt primaries.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

The method suggested would be entirely practical and entirely safe, but not economical. F. G. PROUTT.

This is very bad practice from the point of safety, but from the point of economy little can be said against it.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

R 17. What causes a transformer to generate static current which affects the secondary circuit to the extent that a person can not handle a chandelier or desk fan without receiving a severe shock?

I should imagine that the trouble comes from the secondary wires of that particular transformer being crossed with high-tension wires somewhere—probably series arc. J. F. C.

Never heard of such a case with a good transformer.

W. H. C.

Capacity effect, which could be relieved by lightning arresters on line. G. WILBUR HUBLEY.

We think it probable that the shocks in question were due either to a ground on the secondary circuit or to a static charge generated by friction of electricity caused by the individual walking over a thick carpet or other rough substance. We encountered numerous cases of the latter kind during the past winter on account of exceptionally cold, dry weather.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

Primary current may be leaking into secondary.

THE SEATTLE ELEC. CO.

You will find your transformer defective. You are getting current from the primary circuit, and the transformer should be put out of service to avoid accidents. E. A. Bechstein.

R 18. (a) Does a transformer oil deteriorate through use and to what extent? (b) What are the results of immersing insulation in oil for, say, five years?

I do not know that it deteriorates, but it does evaporate from 10 to 25 per cent per annum. In my judgment, transformer coils once oiled should always be oiled, as the heat has a very bad effect on insulation that has once been immersed in oil and allowed to go dry. J. F. C.

(a) Nothing to speak of. (b) I have a 40-kw transformer that has been in service five years with same oil; insulation is as bright and pliable as the day it was installed.

Fred F. Sharpe.

(a) The oil gradually deteriorates and should be changed at intervals of about three years.

(b) The effect of oil on insulation seems to be a preservative one rather than otherwise. It prevents insulation from becoming dry and brittle and therefore maintains its life and insulating qualities. G. Wilbur Hubley.

R 19. (a) Have you been compelled to place constant-current transformers in separate rooms, on account of insurance rules? (b) Do you make provision for draining the oil from these transformers in case of fire?

(a) No. (b) No. F. C. S., Malden Elec. Co.

(a) No. (b) No. Andrew F. Hall.

(a) No. (b) No. F. Ellwood Smith.

R 20. (a) What is considered the best practice in protecting transformers from lightning—kick coils or lightning arresters, or some of each? (b) What form of ground is efficient and least expensive to install?

(a) Use both choke coils and arresters on high-tension line.

(b) Make ground of copper plate about three feet by two feet; sink into good damp earth and lay on a bed of coke, broken fine, more coke being placed on top, then earth filled in. Keep ground wire as straight as possible; never allow short kinks or turns in it.
A. PETERS.

(a) Lightning arresters. (b) Two-inch pipe driven into the ground until permanent moist earth is met with.
F. C. S., MALDEN ELEC. CO.

It is not current practice to use kick coils in connection with lightning arresters for the protection of transformer. The arresters are used alone and the ordinary line lightning arresters are used for this purpose. Kicking coils are used in stations, however.
C. W. KOINER.

Transformer windings themselves are practically equivalent to kicking coils, and if the line is properly protected with arresters no extra precautions are commercially necessary.
W. H. C.

(a) We are using both on same lines and have had very little trouble.

(b) One-half bushel pulverized charcoal or coke five feet in ground covering good copper plate soldered to wire.
ANDREW F. HALL.

(a) Lightning arresters. (b) Copper-plate ground.
FRED B. SHARPE.

(a) Both lightning arresters and choke coils should be used. The best is none too good. (b) A copper plate surrounded by gas coke to insure moisture is probably the best.
HARRY M. HOPE.

(a) If secondaries are not grounded, transformer windings will, in themselves, act as efficient kicking coils. In cases of severe electric storms, such as we experience in the mountains, we have often found the kick of these windings so strong that heavy insulator-type primary fuse blocks would be shattered into fragments and the metal fused together, leaving transformer windings apparently uninjured. Be liberal with arresters.

(b) Good grounds are not easily made and maintained. Water is the best, if handy and permanent. A good ground in dry localities is made by digging a hole deep enough to get into a little moisture, taking a sheet of copper not less than 20 inches square by one-thirty-second-inch thick, to which is riveted and soldered a piece of No. 0 copper wire, or, better still, two such wire connections extending above ground. Bend sheet into the form of a cylinder, and, when in place, pack inside and outside of it with crushed coke until plate is well covered, then fill in with dirt. CHAS. H. PETERS.

(a) We use both. (b) For a ground we use a galvanized pump-rod half an inch in diameter and about twenty-five feet long, which we drive down beside the pole, soldering the wire to the rod at the top of the ground. L. E. WATSON.

(a) Lightning arresters give the best results, as the transformers act as kick coils. With the transformers acting as kick coils, the lightning arresters are needed to remove the lightning from the wires before it reaches the transformer.

(b) A good ground can be made by burying two sheets of one-sixteenth-inch by three-feet by three-feet galvanized sheet-iron, four or five feet under the surface of the ground, and having same connected together and to the lightning arrester by a No. 6 copper wire. A. M. COVER.

(a) Efficient line lightning arresters on basis of four per mile give good protection. The use of kick coils and station lightning arresters furnishes additional protection. (b) A 16-foot length of galvanized-iron pipe driven into ground to depth of 10 feet alongside of pole forms a good ground when connected by No. 4 copper wire lead from lightning arresters. The question of securing good ground is one of local conditions however. G. WILBUR HUBLEY.

R 21. Is grounding the neutral of a three-wire secondary system found to break down many transformers by lightning?

Grounded secondaries ought not to cause much trouble from lightning if grounding is properly done and single-gap arresters are installed plentifully from neutral to outer wires.

W. H. C.

No. G. H. CUSHMAN.

If the primary wires are not well protected by lightning arresters a grounded neutral of the secondary will aid in a breakdown of the transformer, caused by lightning coming in on the primary wires and jumping to the grounded secondary. This causes an arc which breaks down the transformer.

A. M. COVER.

In four years' service have not experienced any breaking down of transformers by the grounded neutral of a lengthy three-wire secondary. C. C. GARTLAND.

Grounding the neutral of a three-wire secondary system is entirely satisfactory in every way. If it resulted in the breaking down of insulation in the transformer it would still be desirable, as transformers that would not stand service when connected up with grounded neutral should not be used at all.

F. G. PROUTT.

No. W. T. M., N. Y. ED. CO.

Six years' experience with grounded secondaries has not shown any increase in transformer burnouts from this cause.

M. P. R., N. Y. ED. CO.

Our neutral wire is grounded, and during the past three years, although we are situated in the Rocky mountains and therefore particularly liable to lightning storms, we have lost only one transformer from this cause; this transformer was of the shell type and probably not so well insulated between primary and secondary as a core type transformer would be.

S. R. INCH.

R 22. (a) Is it advisable to ground a transformer where using the two-wire system, and (b) is the efficiency affected if the primary or secondary coils are connected in series?

Yes, by all means ground all secondary two-wire systems on one side with single-gap arrester across mains. Never force a static charge taken up by one side to traverse the secondary of a transformer or the meter shunt coils or lamps in a house in order to get to ground. W. H. C.

Do not consider it good practice to ground transformers on two-wire system. G. WILBUR HUBLEY.

(a) It is advisable to ground transformers on two-wire systems. (b) Efficiency of a transformer is independent of method of connection, provided voltage per coil is normal.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

The secondary wires of all transformers whether two or three wires should be grounded. The cost is not excessive and the insurance derived in this way from liability to accidents on customers premises is worth many times the cost of the ground connection. F. G. PROUTT.

(a) Yes. (b) Efficiency is not affected in any way by such connections as are spoken of. W. T. M., N. Y. ED. CO.

(a) It is always advisable to ground secondaries of customers' transformers. (b) Efficiency should be the same whether coils are in multiple or in series. M. P. R., N. Y. ED. CO.

R 23. Should not the grounded "Y" connection be required in transformation from high-voltage to low-voltage distribution system, as a matter of safety to life as well as property?

As a safety precaution, yes. G. WILBUR HUBLEY.

Grounding the neutral of the high-tension side of Y-connected transformers does not protect the low-tension side from trouble resulting from crosses between primary and secondary.
THE SEATTLE ELEC. CO.

In all transformers from, say, 1100 volts up, a grounded neutral is a wise precaution against breakdown of insulation in transformers and cross between primary and secondary wiring outside of transformers. With high-tension transmission systems it may be preferable to ground through a spark gap, in order to relieve the windings of unnecessary strain.

There have been a number of decisions of the court in the last few years holding lighting and power companies responsible for damages resulting from the introduction of primary current on the secondary wiring, the point made by the prosecution being that where absolute means of protection are well known to the art and can be applied at reasonable cost, the defendant was obligated to adopt such precaution, or in case he should not see fit to do so, to be held responsible for damages resulting from his neglect. M. CARRINGTON.

In general, it is safer both to life and to property to ground the low-tension distribution system when there is transformation from a high-voltage line. If the low tension is Y-connected the ground connection should preferably be made at the middle point. If a three-phase secondary circuit is not Y-connected the one ground connection should be made either by connecting one of the three wires or the middle point of one of the three phases. THE WESTINGHOUSE ELEC. AND MFG. CO.

R 24. Has the oil-cooled air-transformer any advantages over the air-blast type for transmission-line work where lightning disturbances are frequent?

Yes. The well-known tendency of oil to reinsulate after puncture, also to kill the arc resulting from puncture, provides a valuable precaution, not possible with transformers of the air-blast type. Furthermore, air-blast transformers are liable to complete destruction of windings from the starting of an arc, due to static discharge. M. CARRINGTON.

Lightning and static disturbances pass much more freely over surfaces in air than they do through solid insulating material. There is therefore less likelihood of discharge taking place in an oil-insulated transformer than in the air-blast type. Furthermore, when a discharge does take place the oil may heal the difficulty and allow the transformer to continue to operate. Numerous cases of this kind have occurred.

THE WESTINGHOUSE ELEC. AND MFG. CO.

The general experience has been that the oil-cooled transformer is much less liable to be burned out by lighting.

M. P. R., N. Y. ED. CO.

Should prefer an oil-cooled transformer for all high-tension work, as the insulation is better protected and better preserved.

N. T. WILCOX.

R 25. Would it be feasible to step down from a line pressure of 10,000 volts to a pressure of 2300 volts, transformer to be located on a pole exposed to the weather? This question arises in the case of a small town too far from the generating station to feed economically at 4000 volts, the load of which does not at present warrant the installation of a substation.

It would be possible to locate a 10,000-volt to 2300-volt transformer on a pole. In a case of this kind I should build a platform, using two poles if necessary, to support transformer, and fuse both primary and secondary. Enclose lightning arresters in water and fireproof box. H. N. CRANDALL.

There should be no reason why such a transformer could not be operated on a pole exposed to the weather, provided the wires are substantially supported and insulated. In one plant with which the writer is familiar two transformers mounted on poles stepping down from 8800 to 2200, have been in service for five years without giving any trouble. H. B. GEAR.

With a good type of transformer and proper construction this might give satisfaction, although it would be best to have a small weatherproof building containing primary switch and cut-outs, with lightning arresters at entrance.

RALPH D. LAXTON.

It is not good practice to step from 10,000 volts with transformer exposed on a pole. While with extra precaution in hanging transformer and disposition of wires, such an installation might operate with apparent success, the risks are too great to be absolutely practicable. LEE BOYER.

This would be feasible. M. P. R., N. Y; ED. CO.

With a first-class oil-insulated and cooled transformer there should be very little trouble if the unit is not too large. Ample lightning protection should be afforded, and transformers should be inspected regularly. A. BALSLEY.

It would be feasible to locate a moderate-sized transformer for stepping down from 10,000 volts to 2300 volts on a pole, provided particular care is taken in protecting the transformer leads. A transformer should be ordered for outdoor work, as some substation transformers would not be satisfactory for pole-line work. W. G. CARLTON.

I see no reason why 10,000 volts can not be used on the transformer to step down to 2300. If necessary, additional protection could be given to keep the insulation on the terminals from deteriorating due to exposure to the air. Of course, in work of this kind, it is absolutely necessary to use the very best makes of transformers. N. T. WILCOX.

R 26. Have any members had trouble with floating-coil constant-current transformers "pumping" or "churning" violently at uneven intervals? If so, under what circumstances or conditions, and what remedy can be applied?

We met this difficulty by clearing our circuits of grounds and reducing the current sent out. We had considerable difficulty in overcoming the trouble and tried so many things that we are not exactly sure just what one thing remedied the trouble.

P. H. KORST.

Have observed slight tendency to pump, due to variable frequency on transformer operated from inverted rotary converter driven by railway generator. Trouble from this cause must, of course, be corrected at generating end of line. Pumping due to line condensance might be remedied by installation of static dischargers on secondary line. Systems operating at a moderate power factor are rather more stable than those whose designers strive for too much in this direction.

RALPH D. LAXTON.

Swinging grounds or sluggish lamps will produce this condition; if regulator is overloaded or oil is too heavy, the same results will follow. G. E. PALMER.

Yes; the cause was a swinging partial ground (trees, *et cætera*). We have found that our "tubs" are excellent ground detectors. By trimming all trees that could touch our arc wires and by putting heavier oil in the transformer dashpots than was supplied with them, we have eliminated the trouble.

S. R. INCH.

R 27. To what extent is the use of the "Two-transformer Resultant Delta" method of transformation liable to unbalance a 3-phase system on full load, where the capacity of transformers is 50 per cent of generating-plant capacity?

Two transformers will not unbalance a three-phase system of connected delta; that is, if the load is not unbalanced.

H. N. CRANDALL.

If two transformers are used on two of the three phases of a three-phase circuit for supplying a three-phase circuit that is equally loaded on all of the phases, there will be very little unbalance. The load will be practically the same on each of the phases of the generator. There will be a slight difference in voltage on the different phases of the secondary circuit, resulting from the unsymmetrical relation of the transformers.

THE WESTINGHOUSE ELEC. AND MFG. CO.

R 28. With a cost of 5 per cent in favor of a 3-phase transformer against three single-phase transformers of same total capacity, which is the more desirable and economical to install to furnish current to a 3-phase induction motor? In other words, would one 3-phase, 15-kilowatt transformer be preferable to three single-phase, 5-kilowatt transformers?

I would recommend three five-kilowatt transformers, for the reason that they are interchangeable and may be used for lighting in other locations if power is discontinued. H. N. CRANDALL.

Modern tendency seems to be toward the three-phase transformer on account of simplicity of installation, economy of space on poles and better efficiency. Where it is practicable to carry a small reserve stock to guard against possible losses, would recommend three-phase transformer. Under most conditions, three or two standard single-phase transformers could be used temporarily to replace a disabled three-phase one.

RALPH D. LAXTON.

Three single-phase transformers are preferable in place of one three-phase, where floor space permits, because should trouble occur from any one transformer, the same can be cut out and service maintained. H. J. MEYER.

The three-phase transformer should give fully as satisfactory results in operating as the three single-phase transformers. The advantage of using the three single-phase transformers lies in the greater flexibility of the arrangement when it comes to making alterations or readjustment of plant.

DUGALD C. JACKSON.

In purchasing transformers, either for lighting or power purposes, only such should be purchased as can be used for either class of service. Two ordinary lighting transformers can be taken and used for power work and should the power work be discontinued, the transformers may be used equally well for lighting service. For this reason if no other it is bad policy to install three-phase transformers that are only suitable for power work. F. G. Proutt.

This question is one that has to be settled for each case separately. If the unit to be supplied is small and the customer has not a long-term contract, the best plan would be to use three small transformers, so that they can be used elsewhere if necessary. If the unit to be supplied is large and the contract is for a long term, it would probably be best to install one three-phase transformer, especially if the floor space is limited.

The three transformers, when connected in delta, have the advantage over one three-phase transformer should a burn-out occur. The motor could be operated on 85 per cent of its full-load on two transformers, while in case of trouble with one three-phase transformer, the entire unit is out of service.

A. Balsley.

S

LAMPS—ARC. INCANDESCENT, ETC.

S 1. In rating alternating-current arc lamps should the apparent or the real watts be the basis?

The rating should be in the real watts. C. W. Koiner.

The real watts, as they determine the light given; preferably the real watts consumed by the arc itself, or "the watts at the arc." Geo. B. Lauder.

In rating alternating-current arc lamps the real watts should be the basis. David W. Beaman.

The real watts. A. R. MacKinnon.

As a question of capacity, the apparent watts should be considered, but as a question of actual power, true watts should be the basis. G. Wilbur Hubley.

Real watts. F. Ellwood Smith.

The basis of rating all alternating-current apparatus should be on the apparent and not the real watts; to do otherwise would be to discriminate in favor of low power factor devices requiring equal unit of investment without the same return.

A. A. P., N. Y. Ed. Co.

In rating for power consumed the load on engine is proportional to the real watts, while the heating, and consequently the load on generator, is limited by apparant watts, or, more exactly, by the current. J. S. Robinson.

Real watts. M. P. R., N. Y. Ed. Co.

True watts, always. J. W. Cowles.

S 2. What are fair ratings for enclosed-arc lamps that are neither 2000 nor 1200-candle-power?

Rating of all lamps where contracts are made with the city should be on the real watts consumed, not in the candle-power.

C. W. Koiner.

The actual watts consumed at the arc. Geo. B. Lauder.

Five hundred candle-power. A. R. MacKinnon.

Alternating-current lamps, 6.6-ampere—about 700 candle-power. G. Wilbur Hubley.

Take the watts at the lamp terminals and rate accordingly.
E. A. M., N. Y. Ed. Co.

One thousand eight hundred candle-power may be a fair rating. Augusta Ry. and Elec. Co.

S 3. What is the cause of hardening of the points of carbons in enclosed alternating-current lamps, with consequent unsatisfactory operation when voltage is correct?

Very likely clutch adjustment is wrong and does not allow lamps to have "sneak feed." By dropping together when at white heat, carbons are very likely to become hardened.
W. H. Greenslit.

Low voltage during some portion of the time the lamps are burning will cause a great deal of trouble on account of the points hardening or glazing over. I have found the trouble to be due to nothing else, and would advise close inspection of the voltage at which the lamps actually operate. Geo. B. Lauder.

Poor carbons. G. Wilbur Hubley.

Carbons may not be sufficiently baked.
Douglass Burnett.

Undoubtedly due to high-resistance carbons.
E. A. M., N. Y. Ed. Co.

Impurities in carbons, or gas cap too tight, not allowing enough air to enter enclosing globe. M. P. R., N. Y. Ed. Co.

Too little oxygen in the inner globe, caused by a too efficient gas cup designed in an erroneous attempt to obtain too long a life from the lamp. This difficulty also occurs when too hard carbons are used.

Remedy: First try another grade of carbons, and if that fails, carefully select by gauging a sufficient number of small carbons for a complete trim of a circuit, and if this remedies the difficulty, as it probably will, it is apparent that less efficient gas cups are needed. G. E. PALMER.

If the voltage is correct, across both the lamp terminals and across the arc, the trouble is probably due to one of three causes:

(1) Impurities in the carbon
(2) Faulty dashpot or clutch
(3) Inner globe too air-tight

The first cause is the more general and is likely to occur with all but the highest grades of carbons. The second cause is likely to occur only in scattered cases, and as a general thing where the trouble is in the dashpot, a new dashpot is necessary, since the plunge and cylinder need to be very carefully fitted for good results. The third cause is very rare in modern lamps, particularly in those with the cap set loose on the globe, but is not uncommon with closed-base inner globes in lamps not provided with a gas groove in the globe cap. S. R. INCH.

S 4. What results have been obtained by the use of five-sixteenths-inch carbons instead of one-half-inch carbons in direct-current enclosed arc lamps of three and five amperes; also in 6 and 7.5-ampere alternating-current arc lamps? What is the additional cost per kilowatt-hour for operation and maintenance, and how is the extra expense justified?

This company has at present 68 five-sixteenths-inch carbon lamps installed in various places throughout the city. All lamps have given excellent satisfaction. The increase in maintenance cost is due to the shorter life of the five-sixteenths-inch carbon. The two items of maintenance cost that are increased are the trimming and cost of carbons. On the lamps now installed a life of from 65 to 70 hours has been obtained. The total increase in maintenance cost on these installations will be approximately 20 per cent greater than with half-inch carbons. The extra expense is justified by giving the customers from 70 to 100 per cent more light. The increase in light is affected by the initial candle-power of the five-sixteenths-inch carbon and a lesser amount of carbon deposit on the inner bulb of the lamp during the life of carbons. G. N. EASTMAN.

The smaller carbons give far better efficiency.
AUGUSTA RY. AND ELEC. CO.

S 5. What has been the experience with the new heat-resisting inner globes?

The new heat-resisting globes have proven very satisfactory.
W. H. GREENSLIT.

Excellent. F. C. S., MALDEN ELEC. CO.

After numerous tests made on heat-resisting inner globes from three different manufacturers on multiple enclosed-arc lamps, the results obtained show that while carbon deposit does not burn in as readily, and bulb will withstand sudden changes in temperature better than the ordinary bulb, the difference in cost makes the ordinary bulb more economical for lamps mentioned above. P. J. SMITH.

Great success has attended their use with lamps in which trouble has been experienced from heat-warped globes. Their use is not necessary with properly-designed lamps.
G. E. PALMER.

We find that 75 per cent of our inner-globe expense is due to breakage in handling and that the heat-resisting globe is as liable to breakage as the ordinary globe; our experience therefore is that the use of heat-resisting globes is an unjustified expense and we have discontinued using them. S. R. INCH.

Excellent. Well worth extra cost. J. W. COWLES.

S 6. What results have been obtained with low-current arc lamps, say three amperes and less, in regard to steadiness of light, burning hours, efficiency, and in general?

We find 3.5 amperes at 110 volts is as low as will give a steady arc. With this amperage we use three-eighths-inch carbon. A three-ampere arc, while of fair quality, is unsteady. The trimming is more frequent than with the five-ampere lamp with half-inch carbon, the ratio being as two is to three. A. PETERS.

Unsatisfactory. G. WILBUR HUBLEY.

We have in operation 1500 3-ampere and about 1500 3.5-ampere arc lamps. A great many of these have been in service a number of years and are satisfactory to our customers. Light is as steady as the 5-ampere lamp and life of carbons is the same. It is advisable to use a carbon of small diameter in a 3-ampere lamp, on account of arc being shorter. P. J. SMITH.

Low-energy arc lamps are not entirely satisfactory, because the proportion of white to blue light is not sufficient, and the lamps do not operate quite so well. The increase in satisfaction with the use of a standard arc lamp will be greater than the increase in the watts consumed. DOUGLASS BURNETT.

The 3.25-ampere arc compares favorably with the 5-ampere enclosed lamp as regards steadiness and burning hours, but, owing to the smaller quantity of light emitted, is not adapted to such universal use as the 5-ampere lamp.

E. A. M., N. Y. ED. CO.

On 106 volts alternating current we have tried the 4-ampere arcs, but found very little demand.

AUGUSTA RY. AND ELEC. CO.

S 7. What are the principal troubles in connection with the operation of series alternating arc lamps, circuits and regulators?

The principal trouble with lamp is confined to balancing weight regulating voltage, since, subject to more or less vibration, it works loose. W. H. Greenslit.

Our principal troubles have been with arc lamps sticking and grounding; also breaking of wires swinging from wires to lamps. Augusta Ry. and Elec. Co.

1. Uneven life of lamps, due to poor regulation of the lamp itself.

2. Poor light and failure to pick up, due to improperly consumed carbons. This is traceable to poor carbons in some cases, but generally to faulty design in gas caps, where in attempting to obtain too long a life, the more refractory parts of the carbon, which are unfortunately of high resistance, are not consumed and form a point of contact in the normal position of rest of higher resistance than the starting resistance in series with the cut-out. If the lamp does pick up under these conditions, it either chatters until the refractory part of the carbon is broken off or it burns at normal voltage with the carbons so close together that the arc can not radiate.

3. Open circuits, occurring during operation where no automatic device is used to open the primary when the break takes place in secondary. In the use of multi-circuit apparatus, the inductive kick that follows rupture is rapidly followed by an increase in potential of from 40 to 60 per cent, which tends to break down line, lamp and station equipment. G. E. Palmer.

The annoying increase in humming when the lamp mechanism is poorly adjusted.

The failure of the series lamp to work properly when one lamp of the series is out of commission, caused by a defect in the cut-out mechanism.

The necessity of using expensive cored carbons.

C. D. Wood, Jr.

S 8. What percentage of total hours outage from all causes is considered reasonable on a system of 1000 9.6-ampere direct-current open-arc lamps; also for alternating-current or direct-current enclosed series?

Two per cent. W. H. GREENSLIT.

During the year 1904, on a system of 789 9.6-ampere open arcs, running a total of 3,115,538 lamp-hours, the total outages from all causes was 3450 lamp-hours, or about one-ninth of one per cent. H. BOTTOMLEY.

Depends somewhat on who reports the outage. We find outage in alternating-current lamps same as on direct-current lamps. We have trimmer inspect every lamp when turned on and our outage is 0.7 per cent. R. N. KIMBALL.

Five-tenths of one per cent total hours outage is considered a reasonable result with an open-arc system. With direct-current enclosed arcs it should not exceed one-tenth of one per cent.
H. T. HARTMAN.

S 9. (a) To what extent are automatic cut-out switches (that is, an automatic device that cuts the lamp out of arc circuit and closes series arc circuits when lamp is lowered) in use? (b) Do they operate successfully on high-voltage circuits?

In the writer's judgment, the least number of automatic switches and fixings you have on a series arc circuit, the fewer open circuits you will have to locate, with consequent interruption of service. J. F. C.

Not very universally in use. Do not think them practicable, on account of the liability of getting out of order and cost of maintenance. Do not see why they would not operate successfully on high-voltage circuits, so long as they are in good operative condition. F. C. S., MALDEN ELEC. CO.

Not reliable or satisfactory to depend on.
G. WILBUR HUBLEY.

S 10. What method can be used to obviate open circuits in the connections between series arc lamps and their absolute cut-outs?

The writer does not know of any method that will entirely eliminate this trouble, but recommends use of a very fine stranded wire with considerable slack which is formed to a pigtail. F. C. S., MALDEN ELEC. CO.

The use of flexible switchboard cable with hard-metal terminals will overcome this difficulty. A. R. MACKINNON.

Use flexible wire of ample length with number of coils in a wire. AUGUSTA RY. AND ELEC. CO.

Use long extra-flexible connections between cut-out and lamp and have the end of the flexible wire that goes into the binding-post of lamp sweated into a solid mass.

G. E. PALMER.

Use brass plugs on ends of wires that enter lamp binding-posts; use finely-stranded wire, and solder it into binding-posts of cut-out. M. P. R., N. Y. ED. CO.

S 11. Is it better on three-phase machines to operate arcs on one phase with incandescents and balance by regulator against other two phases, carrying incandescent single phase, or to distribute the arcs on the three phases?

It is best to separate arc and incandescent load.

W. H. GREENSLIT.

We find it satisfactory to treat all phases alike, and observe that the question of balance practically takes care of itself.

W. P. HAZELTINE.

It is better to put the arcs on each of the phases where conditions are such that it can be done. C. W. KOINER.

The question does not state whether multiple or series arcs. If series, with tub transformers, it will be much better to have two or three tubs connected three-phase, and keep the arcs balanced on the three phases as closely as conveniently possible; this, at least, has been our experience. If multiple lamps, it will be more convenient to put them on all phases and balance up occasionally. Geo. B. Lauder.

It is bad policy to try to use particular phases for particular classes of lighting. The Seattle Elec. Co.

Distributing the arc circuits where possible gives better power factor. Augusta Ry. and Elec. Co.

It is better to divide arcs between phases, because arcs have much lower power factor than incandescents, and it would be difficult otherwise to load evenly all parts of generator windings and keep voltages equal. M. P. R., N. Y. Ed. Co.

S 12. What should be the cost of trimming street arc lamps (carbons, globes, labor, etc.) for a plant operating 600 street arcs, alternating enclosed? Territory covered, 9 square miles.

Assuming lamps burn an average of 11 hours per night—

Cost of carbons	$1.15	per lamp	per year
" bulbs	.15	"	"
" outer globes	.33	"	"
" labor trimming	3.65	"	"
Miscellaneous	.10	"	"
	$5.38		

The above does not include cost of patrolling or lamp repairs. P. J. Smith.

The cost of trimming, repairing, horse and cart maintenance for alternating-current lamps for last year was $8.28 and on direct-current lamps the year previous, $11.43. This is for 125 lamps operated on moonlight schedule 2800 hours.

R. N. Kimball.

S 13. How does free arc-lamp trimming and maintenance cost compare with free incandescent-lamp renewals and with free Meridian-lamp renewals?

The cost is likely to be greater than with incandescents.

DOUGLASS BURNETT.

The free trimming of arc lamps and their maintenance is comparable to the free supply of incandescent lamps. For small equipments, it is better to allow the supplying company to care for the arc lamps and supply incandescent lamps, because the service thus rendered will be done on a better basis. Where, however, the equipment is of larger size, it is to be supposed that the customer will have in his employ some person competent to care for the equipment, and in that case, it is possible to allow him to care for the installation, and also to make renewals, because the party thus employed will be better informed as to what is required than will an ordinary employee.

For Meridian lamps it is different, and in this instance it is possibly better to make a slight charge, say the difference in price between the cost of a standard incandescent lamp and that of the Meridian lamp that may be desired.

C. A. L., N. Y. ED. CO.

For direct-current series enclosed arcs the cost of lamp trimming and maintenance is about $3.50 per lamp per year. With an all-night lamp averaging 4000 hours, or approximately 2000 kilowatt-hours, the total expense per kilowatt-hour would be 0.17 cent. With 56-watt incandescent lamps, averaging 600-hours life, the cost for renewals at 16 cents per lamp would be 0.47 cent per kilowatt-hour. H. T. HARTMAN.

In one instance the cost of free direct-current arc-lamp maintenance was approximately 40 per cent less than the maintenance of free incandescent lamps. The cost of arc maintenance varies with the density of business. In general, each new arc installation decreases the arc-lamp maintenance.

G. N. EASTMAN.

S 14. Sum up the relative advantages and economy of using direct-current enclosed-arc lamps for store lighting, as compared with alternating-current lamps.

The direct-current lamps give a better distribution of light than the alternating-current lamps, are less likely to get out of order, and do not hum. DAVID W. BEAMAN.

Making a comparison of the direct-current enclosed-arc lamp with alternating-current enclosed-arc lamp, as regards distribution of the light given out by each, we find that the alternating-current lamp throws out a larger percentage of its own light along the horizontal line than does the direct-current lamp. The alternating-current lamp, on the other hand, throws a much larger percentage of its light into the upper hemisphere (which must be either practically wasted or thrown downward by reflectors, which are almost universally inefficient) than the direct-current arc. In the direct-current arc this is not the case, as by far the greater portion of the light is thrown into the lower hemisphere; therefore, there is generally accounted to be from 15 to 20 per cent difference in favor of the direct-current arc lamp.

Another important advantage in favor of the direct-current arc is the increased life of the carbons, which amounts to about 125 to 140 hours in the case of the direct-current arcs, while the alternating-current lamp's life is estimated at 75 to 80 hours. S. C. FOSTER.

The economy is in favor of the alternating-current enclosed for store lighting to the extent of 25 per cent, but the distribution of light and the operation of the lamp is better with direct current. DOUGLASS BURNETT.

The direct-current lamp has the following advantages, lacking in the alternating-current lamp; downward and better distribution of light, without the use of reflectors; for the same energy, a hotter crater and in consequence a whiter light; the absence of humming operation, and jumping at starting; absence of external accessories, such as compensators, economy coils, *et cætera*. Economy shows about 25 per cent in favor of the direct-current lamp. E. A. M., N. Y. ED. CO.

S 15. What are the best arguments in favor of arc lighting (interior) as against (a) gasolene (b) acetylene lamps?

Arc lamps give more candle-power for one cent where the price is eight to ten cents per kw-hour than either gasolene or acetylene. C. W. KOINER.

The insurance regulations. J. F. DOSTAL.

1—Fire risk removed. 2—Company maintains the lamps. 3—With suitable globes the light is better distributed and relieved of glare. 4—The color of the light much more true to sunlight. 5—Less heating effect. 6—No vitiated air. 7—Easy control. DOUGLASS BURNETT.

(a) Safety, steadiness, continuity, color, cost, cleanliness and non-vitiating effects on atmosphere. (b) Same as above, with special stress on safety and cost.
E. A. M., N. Y. ED. CO.

Arc lamps are safer and give a far better colored light; are of no trouble to customer in caring for them and no expense except the cost of current; require no matches and have no open flame. AUGUSTA RY. AND ELEC. CO.

Arc lighting is so far superior to gasolene or acetylene lamps in the way of reducing fire hazards, smoking up of valuable decorations and eating the life out of the air the human being must breathe, that a comparison can hardly be made.
E. A. BECHSTEIN.

(a) With the use of the arc there is less heat in summer, no smoke, no fumes and not the danger from fire or explosion. (b) We are now lighting two drug stores that a year ago were using the acetylene lamps, and on our regular commercial scale of rates we are saving them from 10 to 20 per cent, to say nothing of the time and trouble caused by caring for the acetylene system, the danger, smoke, *et cætera*. C. M. WRIGHT.

S 16. With the same care and skill applied, is there any reason why renewed incandescent lamps should not be as good as new ones?

With the same care and skill applied in the manufacture, rating, and sorting of incandescent lamps, there is no reason why renewed lamps should not have as high candle-hour value as new lamps of the same make and type. All other conditions being the same, we believe that in the long run, the renewed lamp is as valuable as the new lamp. The vital question is—Have "the same care and skill" be applied? This can be determined only by a comparison between the new and renewed lamps through a careful test.

A prejudice has long existed against renewed lamps, founded on the fact that some renewed lamps have been worthless. If you wish to know the comparative value of lamps you should have correct tests made.

See page 322 of the 1904 *Question Box.*

ELECTRICAL TESTING LABORATORIES.

Renewed incandescent lamps of tested candle-power are just as good as new ones, but will not, of course, last so long.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

If the paste joints are properly baked and enough heat applied in pumping, there is no reason why a refilled lamp should not be as good as a new one. Of course you run the risk of getting a lamp the cement in the base of which may be of poor quality and allow the base to loosen, a fault that might not develop before the lamp was shipped. S. F. MESSER.

S 17. How far can the target-diagram test of incandescent lamps be depended upon in determining the relative merits of different makes of lamps?

The initial test on incandescent lamps for uniformity and rating does not indicate quality, which is only determined by life and candle-power tests. It can not therefore be depended upon to determine quality of different makes of lamps, but should always be supplemented by life and candle-power tests.

When the lamps tested are from an average barrel and not specially-selected lamps, the target-diagram test is an indication of care and accuracy in the manufacturer's methods.

F. W. WILLCOX.

If the lamp manufacturer knows that you are going to make some tests and secure target diagrams, we think the target diagram is of little use. UNITED ELEC. LT. CO.

Only as to initial performance and indication of the relative care of selection. G. WILBUR HUBLEY.

The target diagram shows the uniformity or non-uniformity of candle-power and efficiency rating of lamps. The very poorest lamps on the market may be accurately rated in candle-power, volts, amperes, and watts-per-candle (though generally they are not) and it is also possible that the very best lamps may be rated badly. The target diagram tells only a part of what you need to know about lamps; an important part, but by no means all. You should also know the average life value of the lamps when burned at their normal voltages. This value is expressed in candle-hours and represents the average life multiplied by the average candle-power throughout that life. Lamps should be well rated and of high candle-hours value. Failing in either condition, they decrease in value. There is no excuse for poor rating of lamps; it is simply a matter of care and cost. Poorly-rated lamps come from indifferent manufacturers who rely upon careless purchasers to buy their product without inspection. Poorly-rated lamps are generally poor otherwise, but "you can't most always, sometimes tell." ELECTRICAL TESTING LABORATORIES.

S 18. What is the present status of the 250-volt incandescent lamp as to life, cost, and efficiency? Are the sockets marked "250 V," now on the market, suitable for this voltage?

The 200-volt to 250-volt incandescent lamp is at present supplied in the following candle-powers and efficiencies:

8-cp, 4.375 watts per candle.
10-cp, 4.25 watts per candle.
16, 20, 24, 32, 50 and 100-cp, 3.8 watts per candle.

In addition to these there is a high-efficiency type of lamp supplied as follows:

16-cp, 3.4 watts per candle.
20-cp, 3.5 watts per candle.
24, 32, 50-cp, 3.1 watts per candle.

The useful life of both the regular and the high-efficiency 200 to 250-volt lamp is approximately the same as the 16-cp, 100 to 130-volt, 3.1-watts per candle lamp; that is, 475 hours to the 80 per cent point of candle-power.

As to cost, the regular 16-cp, 200 to 250-volt lamps are supplied at a cost of two cents higher than the regular 16-cp, 100 to 130-volt lamps. The high-efficiency 200 to 250-volt lamps are supplied at a cost of four cents higher than the regular 100 to 130-volt lamps. F. W. WILLCOX.

The 250-volt incandescent lamp has shown no very great change for several years past, although improved efficiency is promised shortly. The cost is somewhat higher and the lamp life somewhat lower than those of the present 120-volt lamp. The efficiency gained from changing two large installations from a 250 to a 120-volt basis was as follows: Average consumption per day at 240 volts, 915.6 kilowatt-hours; at 120 volts, 695.5 kilowatt-hours, saving 220.1 kilowatt-hours or 24 per cent. Average consumption per day at 240 volts, 522.6 kilowatt-hours; at 120 volts, 410.2 kilowatt-hours, saving 112.4 kilowatt-hours or 21.9 per cent. With this large difference of efficiency it would seem that there is little justification for use of the 250-volt lamp in place of the 120-volt. The sockets now on the market marked 250-V are suitable for the voltage at which they are marked, it being understood that they have been constructed under the specification outlined in the National Electrical Code, rules and requirements of the National Board of Fire Underwriters pertaining to sockets. A. A. P., N. Y. ED. CO.

S 19. What has been found to be the life of the Meridian lamp and how does cost of free renewal compare with free renewal of incandescent lamps?

Where an incandescent lamp for renewal is furnished free a Meridian lamp is furnished at 20 cents.

DOUGLASS BURNETT.

The life of the Meridian lamp averages about 500 hours. Following is comparison of renewal cost per kw-hour for the Meridian and regular types of lamps:

The regular 16-cp, frosted, 50-watt lamp, with a life of 500 hours, taken at a cost of 20 cents, the renewal cost per kw-hour is 0.8 cent.

The regular 8-cp, 28-watt, frosted lamp, with a useful life of 800 hours, taking cost of lamp as 20 cents, cost of renewals per kw-hour, 0.9 cent.

The 50-cp, 120-watt Meridian lamp, with 500 hours life, costing 50 cents, renewal cost per kw-hour, 0.8 cent.

From the above it can be seen that the renewal cost of the Meridian lamp is about the same as that of a frosted 16-cp, 3.1-watt lamp. Comparison is made with the frosted lamp because the Meridian lamp is frosted. As Meridian lamp will be used only in occasional installations, its renewal cost is not a material objection to its adoption, which might be the case were it generally used to replace the regular 16-cp types of lamps.

F. W. Willcox.

We have found the Meridian lamp short-lived, but as we have found it the best thing to compete with gas arcs, we are glad to stand the additional expense. United Elec. Lt. Co.

The Meridian lamp seems to show a very satisfactory life, in fact, so much longer than the high-efficiency standard incandescent lamp that notwithstanding higher first cost the cost of renewal is approximately the same. A. A. P., N. Y. Ed. Co.

S 20. Are the Nernst lamps, 3 and 6-glower type, 220-volt, giving good satisfaction?

Ours give good satisfaction. Fred B. Sharpe.

Yes. G. H. Cushman.

The Nernst lamps of the three and six-glower type, 220 volts, are giving satisfaction where installed.

J. P. R., Jr., N. Y. Ed. Co.

We have abandoned the use of Nernst lamps, as they require too much attention and care. Augusta Ry. and Elec. Co.

Yes. J. W. Cowles.

S 21. On what basis do you furnish installations and renewals of Nernst lamps as compared with standard incandescent lamps?

Consumer buys lamps and pays for repair parts.
Fred B. Sharpe.

Better have the Nernst people sell the lamp, and make a maintenance contract with the customer until you believe it better to do otherwise. Douglass Burnett.

The Nernst lamp is installed at the company's expense and the renewals, including heater tubes, glassware and glowers, are furnished free to the customer, the same as any standard incandescent lamp would be. J. P. R., Jr., N. Y. Ed. Co.

We furnish the Nernst lamps without charge and care for them free of charge, just as we do standard incandescent lamps.
A. C. Dunham.

We purchase, install and maintain the Nernst lamp the same as commercial arcs. We, however, charge a minimum rate of $1.00 per month per lamp installed. S. F. Messer.

When Nernst lamps are sold by the company, the company furnishes renewals of glowers and heaters free of charge.
The Philadelphia Elec. Co.

On installation of Nernst lamps, we require the customer to purchase the lamps, and we furnish free renewals. We follow this same plan on incandescent lamps. Homer Honeywell.

Nernst lamps furnished on the same basis as arc lamps, furnished and trimmed by the company. J. W. Cowles.

We furnish renewals and give maintenance without charge to customer on all installations of Nernst lamps, making the minimum bill $1.50 per lamp per month. D. H. Beardsley.

S 22. Does the Nernst lamp maintain its candle-power as well as a 3.5-watt incandescent lamp?

Better. FRED B. SHARPE.

It is our experience that the candle-power of the Nernst lamp is maintained as well as that of the 3.1-watt incandescent lamp. J. P. R., JR., N. Y. ED. CO.

The Nernst lamp, in a certain sense, is to be regarded as a constant-efficiency lamp, inasmuch as after a decrease in candle-power of about 15 per cent, which takes place in 300 hours, the candle-power remains practically constant, owing to the fact that the addition of new glowers just about makes up for the deterioration of the old glowers. Inasmuch as there is a constant decrease in the incandescent lamp during its life, these two lamps can hardly be placed on the same basis in this respect.

E. R. ROBERTS.

S 23. From a manager's standpoint, is a Nernst multiple-glower lamp preferable to a multiple-arc lamp? Is a single-glower lamp preferable to a Meridian lamp?

(a) No. (b) I think not. F. C. S., MALDEN ELEC. CO.

The standpoint is not defined in the question asked. Some customers would select the Nernst in preference to the arc lamp, but as the Nernst lamp of two, three or four glowers consumes less current than a standard arc lamp, the Nernst may appeal to more customers than the arc lamp. For a large store requiring a high grade of general illumination, it would be difficult to improve on arc lighting when the lamps are properly selected, arranged and cared for. DOUGLASS BURNETT.

As to the use of the Nernst multiple-glower lamp in preference to a multiple arc lamp to a large extent, this depends upon location. For outdoor work and large open areas the multiple arc lamp is better. This refers to the 6 or 7.5-ampere arc lamp generally used. For smaller areas, the window lighting in particular, either inside or out, the three-glower Nernst lamp is more desirable than the arc lamp. J. P. R., JR., N. Y. ED. CO.

We think that the Nernst lamp has certain advantages over the arc lamp. It certainly can be used in places where the arc is not available. The capital invested is about the same and the care of the lamps very nearly equivalent in cost. The Nernst lamp is the only lamp with which we are acquainted that will displace the gas arc, which it invariably does without much trouble on our part. A. C. DUNHAM.

Original cost too high on Nernst lamps.
R. N. KIMBALL.

At the present stage of the Nernst lamp, a single-glower lamp would hardly be considered, from the station manager's standpoint, as preferable to a Meridian lamp of equal candle-power. The Meridian lamp is much less liable to trouble, and if burned out can be renewed by the consumer. The renewal of the glower in the Nernst lamp by the consumer is hardly practicable, and would generally necessitate sending a man to perform the work. THE PHILADELPHIA ELEC. CO.

From a manager's standpoint the multiple-glower Nernst lamp is preferable to the multiple arc lamp, when the customer purchases the lamp, because it improves the power factor of the load, gives a steady light of excellent quality, and the current consumption of the Nernst lamp will be equal to, if not greater than the consumption of the arc lamp that it replaces.
HOMER HONEYWELL.

Owing to the short time we have had lamps installed it is impossible to pass an opinion, but at our rate for current we are competing successfully with gas arcs with gas at $1.00 per 1000 feet. D. H. BEARDSLEY.

S 24. What per cent is the life factor of a Nernst lamp decreased by variation in voltage of 4 per cent or 5 per cent each side of normal? This fluctuation to occur, on an average, twice in an hour.

To answer this question satisfactorily a special test should be made. As none has been made, data on the subject can not be given. From *observation* and *experience* the life of the glower is materially affected by this fluctuation.

J. P. R., Jr., N. Y. Ed. Co.

The writer has determined that the life of the Nernst glowers is decreased about 25 per cent when the lamps are run constantly at an overload of five per cent above normal, and that occasional fluctuations of five per cent, such as are referred to in the above question, do not have any appreciable effect on the glower life.

E. R. Roberts.

S 25. Is the objection, raised by some, that the mercury-vapor lamps are injurious to the eyes, well founded?

I have never heard the complaint that the light from mercury-vapor lamps is injurious to the eyes. It is claimed by the manufacturers that on account of the omission of the red rays the light is especially adapted to detailed work, such as drawing, *et cætera.*

C. H. B. C., N. Y. Ed. Co.

The general impression that the Cooper Hewitt lamp is harmful to the eyes results from the color of the light. No such conclusion should be formed, as the light is not harmful, but more beneficial than any other artificial illuminant. A simple explanation of this is as follows: Sunlight is composed of all colors; some of these colors are more fatiguing to the eye than others, red being especially objectionable. The spectrum of the Cooper Hewitt light comprises all the colors of sunlight except red, thus making the light particularly favorable. An additional reason in favor of the lamp is the great diffusion of light, due to the tubular form, eliminating dark shadows and bright spots. That the lamps have been used for the past two years in composing and drafting-rooms is sufficient evidence of their non-injurious effect, as there is no work that is more trying on the eye than that done by compositors or draftsmen.

That the men who work under the light appreciate it, is well illustrated by the following experience: A number of Cooper Hewitt lamps were used experimentally, for a period of some months, in the composing-room of a New York newspaper. The management, on account of increased expenses in other departments, intended to defer the permanent installation of the lamps for some time. The men who worked under the light, hearing of this, requested that the trial lamps be not removed, and the argument was sufficiently strong to cause the management to make a complete installation of the lamps.

The light has been used successfully for the past year or so in the drafting-rooms of the Westinghouse Electric and Manufacturing Company, the Robins Conveying Belt Company, the Cutler-Hammer Manufacturing Company, and the Link-Belt Engineering Company, and the composing-rooms of the New York *Times*, the New York *Staats-Zeitung*, the German *Herold* and the New York *Evening Post*. All of these concerns unite in commending the light, particularly on account of the ease on the eyes. WILLIAM A. D. EVANS.

S 26. Is the Cooper Hewitt mercury-vapor lamp considered satisfactory for window lighting, especially as regards the green tinge being noticeable?

Only as a special temporary display to attract attention. DOUGLASS BURNETT.

The mercury-vapor lamps have been used to some extent for window lighting, but merely to attract attention on account of their peculiar color. After the novelty has worn off, they are not satisfactory for window lighting, and this fact has been recognized by the manufacturers, who do not advertise them for this class of service. C. H. B. C., N. Y. ED. CO.

The Cooper Hewitt mercury-vapor lamp is not considered satisfactory for window lighting in any case where it is necessary to display colors, on account of the lack of red rays. Owing to this characteristic, it is considered that its field for window lighting is limited. THE PHILADELPHIA ELEC. CO.

The Cooper Hewitt mercury-vapor lamp can be favorably used for window lighting when placed above the line of vision, so as not to dazzle the eyes. It should never be placed in a window where red goods are to be displayed. The green tinge gives any window where the lights are used a distinctive color which readily attracts the eye. WILLIAM A. D. EVANS.

Where the sole object in lighting the window is to attract attention by being entirely different from the lighting of other windows, and where the goods displayed are not affected by the color of the light rays falling upon them, the mercury-vapor arc is satisfactory from a lighting standpoint. Examples of such may be found in stores where the goods are in black and white, such as in a window showing engravings, black shoes, *et cætera.* In this case the difference in color from that of the surrounding stores is so pronounced that it attracts immediate attention, and from this standpoint is extremely satisfactory. Where, however, the color of the goods displayed is attractive in itself, the light from a mercury-vapor arc is decidedly objectionable, owing to the almost complete absence of any rays from the lower part of the spectrum. Thus in the case of dry goods displayed, the color red in daylight will, depending on the dye used, be a brilliant purple at night, and so on with all of the lower colors, whereas the colors in the upper part of the spectrum are beautifully accentuated by the color of the light. Generally speaking it is only in rare cases that it is desirable to light windows with any type of mercury-vapor arcs. V. R. LANSINGH.

The Cooper Hewitt lamp is not satisfactory for window lighting, except when it is used over black and white colors, such as plumbers' supplies, shoes, *et cætera.* It may also be used as a novelty to attract attention. It is unsatisfactory for general use, owing to absence of red rays. C. R. BROWN.

S 27. Describe recent installations of latest type Cooper Hewitt lamps, giving results and comparison with arcs and incandescents for factory, machine shop, printing presses, etc.

The use of mercury-vapor lamps in studios, photograph galleries and places of this description is now so well known that it need hardly be mentioned. There have been recently some very interesting installations, however, for general illumination, which I shall describe in detail.

The press-room of the new *Times* building, Forty-second street and Broadway, is lighted by 22 Cooper Hewitt lamps rated at 300 candle-power each. The floor area is 5620 feet.

The total installation requires 4.5 kilowatts at 120 volts, or an average of 0.74 watt per square foot. The lamps are so placed that there is a good illumination on all parts of the presses.

In the composing-room of the *Times* building there are eight 300-cp lamps. The floor area in this room is 1200 square feet and the lamps require 1.54 kilowatts. This is an average of about 1.3 watts per square foot.

The Panama Steamship pier, at the foot of West Twenty-seventh street, is lighted by six Cooper Hewitt lamps, and has a floor area of 39,770 square feet. This is an average of 0.06 watt per square foot, and I understand from the customer that the lighting is very satisfactory for this class of work. There is also one light in front of the pier, which is not included in the figures given.

The installation in the business office of the American Tobacco Company, 111 Fifth avenue, is somewhat different from those I have mentioned, as two incandescent lamps are used in connection with the Cooper Hewitt lamps to furnish the red rays that are missing in the mercury lamps. The floor area is 11,250 square feet, for the lighting of which 32 Cooper Hewitt lamps and 64 incandescents have been installed. Even with the incandescent lamps included, the consumption of current is only 0.8 watt per square foot.

Possibly the best example of decorative effect that may be obtained with the use of mercury lamps, is found in the new Hotel Astor, Forty-fifth street and Broadway. All the lamps are hidden in a cornice running around the room and the objectionable color is counteracted by a limited use of incandescent lights. There is also a lamp installed in a reflector over the fountain. This installation is in the Orangerie, but I have no figures to show the amount of current used on the floor area of the room.

A number of other very interesting installations could be mentioned where the lighting effects are entirely satisfactory to the customers. C. H. B. C., N. Y. Ed. Co.

PLACE	Character of Work	Old Installation	Kw Used at 110 Volts	No. of Hewitts	Kw Used at 110 Volts	Saving in Kw	Cp per Hewitt Lamp	Total Cp	Total Sq. Ft. Illuminated	Sq. Ft. per Hewitt Lamp	REMARKS
American Tobacco Co.	Office	250 16-cp Incandescents	13.75	32 Type H	6.1	7.65	300	9,600	11,250	600	......
Bamford Bros. Silk Mfg. Co.	Weaving-room	19 9-amp. Arcs	18.8	25 Type H	4.8	14	300	7,500	6,700	270	Have 39 lamps in other departments
Butterick Publishing Co.	Press-room	New Building		44 Type H	8.5	..	300	13,200	18,000	410	Have 20 lamps in other departments
German *Herold*	Composing-room	172 16-cp Incandescents	3.9	8 Type H	1.5	2.4	300	2,400	1,200	150	......
Graton & Knight Mfg. Co.	Leather factory	420 16-cp Incandescents	23	70 Type H	13.4	9.6	300	21,000	28,000	400	......
Link-Belt Eng. Co.	Drafting-room	10 6-amp. Arcs	6.6	6 Type K	2.3	4.3	700*	4,200	2,000	333*	......
Merganthaler Linotype Co.	Machine-shop	67 16-cp Incandescents	3.7	10 Type H	1.9	1.8	300	3,000	5,400	540	......
New York *Times*	Press-room	New Building		22 Type H	4.2	..	300	6,600	5,600	255	Have 22 lamps in other departments
New York Transportation Co.	Storage-battery-room	14 5-amp. Arcs	7.7	10 TypeV-5	3.8	3.9	700*	7,000	12,600	1,260*	Have lamps in other departments
Panama Railroad	Pier	Gas†	..	6 TypeV-5	2.3	..	700*	4,200	39,700	6,600*	......
Robins Conveying Belt Co.	Machine-shop	New Building		10 Type K	3.8	..	700*	7,000	11,528	1,100*	Have lamps in other departments

*** These lamps consume 385 watts each and give 700 candle-power; all other lamps consume 192 watts and give 300 candle-power.**

†Old installation consisted of 190 five-foot gas burners, which in cold weather gave a very feeble light. With Cooper Hewitts the illumination has been greatly increased, and the saving effected has amounted to about 20 per cent, including renewals and so forth.

This question can best be answered by the above table, which shows the efficiency of the Cooper Hewitt lamp over both arc and incandescents in recent installations.

WILLIAM A. D. EVANS.

S 28. (a) What is the best way of turning multiple lamps or electric signs on and off at predetermined hours—by patrolmen or by means of automatic time switch? (b) Have you found a practical and reliable time switch for the purpose?

(a) Automatic time switch. (b) The writer thinks that there are two or three time switches that are reliable.

F. C. S., MALDEN ELEC. CO.

Until you have 100 or more signs, better have your night inspector of arc lamps control the signs. Thus you get personal inspection every day, which is a guarantee of proper maintenance. An automatic time switch requires weekly attention for winding, and hence some labor. The use of electric signs controlled by your inspectors is an assurance that your men are covering their districts. The Anderson time switch is first-class, but men are better. DOUGLASS BURNETT.

(a) It is considered that the most satisfactory way of operating multiple lamps or electric signs at predetermined hours is by the use of a time switch. (b) The Ballon-Hutchinson and the Anderson time switches seem to be very reliable and satisfactory for this purpose. THE PHILADELPHIA ELEC. CO.

(a) When it is practicable to install an auxiliary wire, this problem is easily solved by the use of remote-controlled switches. The writer has recently designed several types of switches for different classes of service, and, as far as the system has been developed up to the present time, he believes it is perfectly practicable to control from the central station, either selectively or as a unit any combination of multiple arc lamps or electric signs that it is desired to operate from low-tension mains.

(b) There are several excellent time switches on the market, the element of reliability in their operation being lacking only because the majority of mankind believe that they know more about "fixing a clock" than does the manufacturer.

On the remote-control unit system referred to, a momentary closing of a switch connected to the auxiliary wire turns on or off the lamps desired to control; in the selective system, a

number of current impulses of one characteristic select a lamp, or group of lamps, which are then independently switched on or off with a current impulse of a different characteristic.
G. E. Palmer.

The most certain method of insuring the turning off and on of electric signs, or other flat-rate installations, is by the patrolman. There is always more or less trouble with automatic time switches. H. T. Hartman.

By means of automatic switches. Several such switches reliable in operation are on the market, although not at as low a price as might be desired. J. W. Cowles.

S 29. What should be the characteristics of an incandescent lamp to operate satisfactorily on 25 cycles?

An incandescent lamp that will give a satisfactory illumination when operated from a 25-cycle circuit should have a thick filament so as to prevent customer from complaining of a slight flicker in the light. (See the bulletin of the University of Wisconsin, Engineering Series, Vol. 2, No. 10.)
Dugald C. Jackson.

Four watts per candle. Douglass Burnett.

Large filament, large current and low wattage.
Augusta Ry. and Elec. Co.

S 30. Where incandescent lamps are used for street lighting, what candle-power lamp should be used?

Depends upon local conditions. A fairly even distribution of light may be obtained on open streets by 16-cp lamps 100 feet apart, though ordinarily not less than 32-cp are used with spacing of 150 to 200 feet or more. Ralph D. Laxton.

Incandescent lamps for street lighting should not be of less than 32 candle-power nor more than 50 candle-power. Use 32-cp lamps singly and in clusters. Lee Boyer.

The 25-cp lamp is the most common, but I believe that 32-cp is a great deal more satisfactory. F. ELLWOOD SMITH.

Thirty-two-candle-power or 50-candle-power.
DOUGLASS BURNETT.

Lamps of 16 and of 32 candle-power are often used, but 50-cp lamps give better satisfaction.
AUGUSTA RY. AND ELEC. CO.

Lamps of 50 or 75 candle-power are generally used.
M. A. HOGAN.

Lamps of 25 or 32 candle-power, according to degree of illumination desired. J. W. COWLES.

Use a regular shunt box and a 25-cp, 4-watt lamp. This will give plenty of light and is a very good lighter.
FRED M. LEGE, JR.

When incandescent lamps are used for street lighting, 25-cp is a very good size to use. THOMAS S. RICHARDSON.

S 31. (a) Is the Nernst lamp much used for street lighting? (b) Does it prove satisfactory for such work, and what are its faults?

We use Nernst lamps on streets and have no complaint to make, as our lamps are giving satisfaction. We have to take them down only once every two months. I would suggest to lighting plants that are going to put in the Nernst lamp for street service that they use six-glower lamps. C. T. HARNEY.

The Nernst lamp is used in some instances for street lighting, but not generally, because it will not burn in series.
H. J. MEYER.

While the Nernst lamp is not extensively used for street lighting, it can be used with good success. The failure of Nernst

lamps in street lighting can be traced to failure to furnish rigid support for lamp, and to incompetent attendants.

Lee Boyer.

(a) This company uses 250 single-glower lamps for street lighting in the town of West Hartford. (b) These lights have been running over two years and please the people very much indeed. We find the lamp easily taken care of and giving results that are satisfactory to the company. A. C. Dunham.

We have in use several three-glower and six-glower lamps as street lights, and they have given very satisfactory results.

G. H. Cushman.

We have in use at present 90 six-glower Nernst lamps for street lighting in Sewickley. This installation has now been in use for about five years and, with the lamps installed at a good height, they have always given good satisfaction. During our earlier experience, a careful record was kept from which the total maintenance was estimated at slightly more than half a cent per kilowatt-hour. This we estimated to be slightly less than a corresponding cost for enclosed arcs. This difference is to a great extent due to the saving in glassware.

J. M. Uptegraff.

One of the difficulties of the Nernst lamp for street lighting to-day is due to its distribution curves. The light must be placed vertically and as at present constructed the end-on candle-power is too high, producing a spotted effect. This is also true of the ordinary type of arc where the maximum illumination instead of being directly under the light (as in the case of Nernst lamps) is about 10 or 15 feet away from the pole with a very marked decrease as it goes farther toward the minimum, half-way between the two lights. It is necessary, in order to use the Nernst lamp properly for street lighting, except where the lamps are placed very high and close together, as in a crowded street, to correct the distribution curve. Lamps should also be carefully placed with the axis of the glower at right angles to the street, so as to get the maximum illumination up and down the street instead of across.

A further necessity in street lighting with Nernst lamps is to use a diffusing globe, inasmuch as the intensity of the glowers with a clear glass ball is so dazzling as to render it useless for lighting where there is any danger of its coming directly in line of vision.

There has recently been put on the market a new globe for the No. 1 Nernst, which effects a marked change in distribution of the Nernst light over the sand-blasted ball. The diffusion is even better than the sand-blasted ball, while the candle-power directly underneath the lamp is cut down from 46 to 32 and the candle-power at 10 degrees below the horizontal (the most useful angle) is increased from 23 to 35.

As yet there are no globes on the market, other than for No. 1 glower, although it is understood that it is the intention of the manufacturer of this globe to design new globes for this purpose.

The following is a table showing the results with a sand-blasted and the new globe for No. 1 Nernst glower, the readings being the mean of four planes at 0 degrees, 30 degrees and 90 degrees apart:

Degrees	New Globe	Sand-blast Globe
140	4	..
135	4	..
120	5	..
105	6	9
90	25	17
75	38	25
60	39	35
45	31	41
30	31	44
20	35	49
10	34	47
0	32	39

The readings above given are from tests made by the Electrical Testing Laboratories. V. R. Lansingh.

S 32. What are likely to be the causes of the sticking or welding together of the carbon points in alternating-current series enclosed arcs, especially when it occurs simultaneously in several lamps on a circuit?

Crooked carbons. Low voltage will cause the carbons to fall together. If any lamp is adjusted to receive more current than its portion at the arc, the balance will jump and the carbons then come together. Poor carbons also cause this.

Madison Lt. and Ry. Co.

If clutches work properly and carbons are of good quality, current must be too high. Ammeters should be tested for proper calibration and transformer adjusted to give current reading in proportion to amount of load carried. For example, one prominent manufacturer gives a range of adjustment from 6.6 amperes ammeter reading at 100 per cent load down to 6.35 for 50 per cent load. This corrects ammeter errors due to variable power factor, *et cætera,* and gives approximately same current at lamps in each case. RALPH D. LAXTON.

Low voltage. AUGUSTA RY. AND ELEC. CO.

Your trouble is more than likely in the weights, which come loose in spite of everything you can do. I think this is due to expansion and contraction. FRED M. LEGE, JR.

Impurities in carbons. M. P. R., N. Y. ED. CO.

The welding together of carbons under conditions described is probably due to their slipping through the clutches.

Several cases occurring simultaneously would probably be occasioned by some condition of jarring the lamps, such as a wind storm, or the pumping of a tub transformer, or, possibly, jar from heavy traffic in the street.

To remedy this the carbon used should not be too "slick and shiny" on the surface, and the clutches should be carefully adjusted so that they grip the carbons firmly—except, of course, when about to feed—and care should be taken that the lamps have no undue internal vibration, as, for instance, from a magnet armature drawn up so far that the yoke rests against the magnet spools. P. C. BROWN.

I should say the lamps are out of adjustment. When armature hits against solenoid it keeps jarring the clutches and drops carbon down so that points come together.

JOHN J. GAFFNEY.

T

HEATING, BATTERY CHARGING AND POWER

T 1. What are the central stations doing to help along the electric-heating industry?

Extensive advertising and low rates for this class of work.
UNITED ELEC. LT. CO.

Advertising things that would be used intermittently; selling special lines at practically cost as "leaders;" getting supply houses to canvass for and sell the apparatus; arranging demonstrations in their own show-rooms or in department stores, giving the customer the privilege of using heating service on either lighting or power contracts and meters, without taking note of the apparatus, as a part of the installation, and hence increasing the tendency of low rates for both classes of service.
DOUGLASS BURNETT.

Articles on the subject appear each month in the New York Edison *Bulletin*. Circular letters and return postal cards are sent out with bills. Heating and cooking appliances are displayed in the branch offices of the contract department.
C. W. R., N. Y. ED. CO.

Most stations carry a small stock of heating apparatus, but few of them do one-half the business they might by a little more vigorous soliciting and advertising. You can not expect goods to sell themselves unless their merits are entirely familiar to your customers. H. T. HARTMAN.

From data that the writer has been gathering, it is evident that most of the central stations seem to be carrying a stock of heating apparatus, and advertising such apparatus more or less in the papers, *et cætera*. Very few of them make anything but the regular lighting rates, and practically none of them solicit specially or make any particular inducements for the use of heating. They all seem to be very much interested, but the general opinion seems to be that much of the apparatus is beyond the means of the average consumer, both in first cost and cost of operation. JOHN F. GILCHRIST.

T 2. Does the extensive use of heating appliances prove to be a desirable load?

We find that the heating appliances prove to be a very desirable load. UNITED ELEC. LT. CO.

Yes, in the case of such appliances as electric irons in laundries, clothing shops and hat factories. No, in the case of residences, in which latter the average use per day is no greater than with lighting. DOUGLASS BURNETT.

Yes. Heating devices take a steady current and mostly at the non-peak hours. C. W. R., N. Y. ED. CO.

There can be no doubt of the desirability of the load afforded by heating appliances. The current required, however, is so very small and so intermittent that it is doubtful whether the comparatively limited amount of heating appliances in use really affects the load of any central station. But even if it had no effect at all it would still be most desirable for the central stations to extend the use of heating appliances, as anything that tends to make electricity convenient and popular will undoubtedly increase its general application.
H. T. HARTMAN.

T 3. What is the best method of charging storage batteries used in carriages?

Arrange with some active stable keeper or garage to provide charging facilities; or provide them yourself at your stable and station; or have your customers provide them at their homes on either direct-current 220-volt, direct-current three-wire or alternating-current lighting service—in the first two instances in connection with rheostat, and in the third instance in connection with a mercury arc rectifier. DOUGLASS BURNETT.

The 40-cell carriages are charged at 20 amperes until the proper voltage is reached, when the current is reduced to 10 amperes and kept on until the voltage is again normal.

Half-hourly readings are taken in order that the batteries may not be injured by an overcharge.

E. A. N., N. Y. Ed. Co.

There are no two storage batteries that require exactly the same treatment as to rate of charge, *et cætera.* The best way to do is to have the owner get from the manufacturer of the storage battery, definite instructions as to the best way of charging each particular battery. Geo. H. Jones.

The difficulties ordinarily met with in charging automobile storage batteries at points where direct current of the proper voltage is not immediately obtainable, consist in finding a cheap and efficient apparatus for adapting the source of supply to the voltage required for the battery in question. The usual method employed where the only available source of current is alternating, is the use of a rotary converter or motor-generator. This method involves the use of expensive apparatus, special transformers, *et cætera,* and requires almost constant attention from an attendant, while the expense is considerable, particularly in the case of a private installation. Any method of obviating these difficulties to a large extent might be considered the best method of charging. The use of a mercury-vapor converter—operating directly from the local alternating-current circuits and producing a steady direct current, capable of being adapted to suit the battery to be charged—overcomes most of the difficulties mentioned and enables all transformation and regulation of current to be performed by a practically self-contained outfit. Percy H. Thomas.

T 4. Is there a good, strong, practical rectifier for charging automobile batteries from alternating-current circuits?

There are two well-known rectifiers on the market that have thus far given good results. It is stated that an efficiency of 80 per cent is secured. The tubes are guaranteed for 400 hours but the manufacturers claim that the actual life is much longer, some having been in use over 1000 hours. The tubes when exhausted may be renewed at a slight cost.

E. A. N., N. Y. Ed. Co.

In this connection we desire to call attention to a certain make of mercury-vapor converter with which the writer has been associated. This apparatus employs alternating current derived directly from the local lighting or power mains, and delivers direct current which may be regulated by means of a handle mounted upon a switchboard so as to suit the requirements of any ordinary electric vehicle battery. The efficiency of this apparatus varies from 80 to 85 per cent, thus exceeding by a considerable margin the ordinary efficiency of rotary converters and motor-generators. The apparatus is simple and entirely automatic, the control and regulation of current being effected by the manipulation of two switches and a regulating handle. The apparatus requires no expert attention, has practically no moving parts, does not require lubrication, and occupies only a fraction of the space required by a rotary converter or motor-generator, and weighs far less. It may be mounted upon a table or shelf, or by brackets against the wall, taking little or no valuable space. It will also automatically restart in case the current supply is temporarily cut off, while the danger from a discharge of current from the battery into the source of supply, frequently encountered in rotary converters and motor-generators and due to temporary lowering of the supply voltage, is entirely eliminated. Percy H. Thomas.

The mercury arc rectifier is considered satisfactory for charging automobile batteries on alternating-current circuits.

The Philadelphia Elec. Co.

T 5. What is the experience of members with mercury-vapor rectifiers for automobile-charging stations?

Mercury rectifiers are said to give entire satisfaction.

E. A. N., N. Y. Ed. Co.

The continued use of mercury-vapor converters of a certain make has shown them to be particularly free from the kind of troubles met with in motor-generator apparatus. They require no oil, there is no danger of hot bearings and, unless overloaded or abused, apparatus in a vacuum, like the Cooper Hewitt mercury-vapor lamp, seems to suffer no deterioration. They are not sensitive to temperature, dirt, and so forth.

PERCY H. THOMAS.

Two mercury arc rectifiers have been in service for one month and three months, respectively, and have proven fairly satisfactory. The apparatus is apparently capable of satisfactory operation with unskilled attendance.

THE PHILADELPHIA ELEC. CO.

T 6. (a) What is the usual price for current for charging the batteries of electric vehicles? (b) Is a minimum charge advisable? (c) Is it customary for the central station to fill the batteries with electrolyte?

We make a special rate of five cents a kilowatt-hour to those customers guaranteeing to use a day or night service, and keep off the peak; minimum charge $2.00 a month; our regular rate 10 cents. DOUGLASS BURNETT.

(a) This company has two rates that charging outfits may secure. One at six cents per kilowatt-hour with a guarantee of $50. This of course is only applicable to large installations.

(b) The rate generally used is the ordinary power rate of 10 cents per horse-power with discounts, and a minimum of $3.00 per month.

(c) The question of refilling batteries with electrolyte is one of maintenance and under no circumstances should be undertaken by central stations whose business is simply to sell current. E. A. N., N. Y. ED. CO.

(a) It is good practice to sell current for charging automobiles on the power basis, figuring rates, minimum bills, *et cætera,* the same as for general power purposes. (c) I think that the business of the central-station company should end with the delivery of current to the consumer's switchboard. The owner should look after and be responsible for the care and maintenance of the battery. GEO. H. JONES.

(a) We install meters in charging stations with a minimum rate of $3.00 per month. (c) We have nothing whatever to do with the batteries. S. F. MESSER.

T 7. How would the advent of a cheap and satisfactory alternating-current rectifier affect the alternating-current motor business? Would the direct-current motor drive the alternating-current motor out of the field?

No; not even if the rectifiers were given away with the direct-current motors. J. T. COWLING.

(a) Probably would not help it. (b) No.
DOUGLASS BURNETT.

The advent of a cheap alternating-current rectifier would no doubt eliminate alternating-current motors for many installations where they are now used, and where the direct-current motor would be more desirable from speed and torque considerations. However, there are many purposes for which the alternating-current motor is peculiarly adapted. It is simple in construction, practically fool-proof, can never run away, has no wearing parts except armature bearings, can not be easily burned out by overloading, and therefore, has advantages peculiarly its own, just as the direct-current motor has advantages peculiarly its own. G. H., N. Y. ED. CO.

Since each type of motor has its field there seems little danger of such an event. Alternating-current motor development abroad is along lines that broaden the field and indicate that future sales will even exceed the increase over direct-current sales during the past two years. Logical reasons as well as practical results are in favor of the rugged alternating-current motor as against the double commutation or combination of rectification and subsequent motor commutation.
THE PHILADELPHIA ELEC. CO.

The effect of an alternating-current rectifier on alternating-current motor business would be nil. The alternating-current motor has come to stay and it is only a matter of time until it will be displacing the direct-current motor to a very large extent.

F. G. PROUTT.

In many cases it would cause a change from alternating to direct-current motors, especially where variable speed is of prime importance. A company has already brought out a variable-speed single-phase motor, however. I hardly think that the alternating-current motor will ever be driven from the field by the direct-current motor, especially now that many alternating-current motor patents are expiring and the price will be lowered.

W. R. COLLIER.

The advent of a cheap and satisfactory alternating-current rectifier would be very desirable. I do not think, however, it would have much effect on the alternating-current motor business except in special instances where wide speed variations are necessary for small motors. The alternating-current motors are here to stay. As the present prices for them compare favorably with those of direct-current motors and in some cases are lower, the use of the alternating-current motor is bound to increase.

GEO. H. JONES.

The advent of a satisfactory rectifier would materially lessen the alternating-current business. The cheaper generation and distribution of alternating over the direct current would cause this method to be introduced.

(b) The greater adaptability to commercial conditions of the direct-current motor would tend to drive the alternating-current motor out of business.

C. D. WOOD, JR.

T 8. Which is more important to the central station—high power factor or high efficiency in the apparatus receiving power from the station?

Central-station managers might say that high power factor is the more important consideration. On the other hand the chief of the complaint department, to whom complaints of high bills come, would probably say that high-efficiency apparatus is of greater importance. No doubt both are very important.

GEORGE HOWE.

High power factor, as that not only affects the capacity of the generating apparatus but the capacity of all transmission lines as well. THE EDISON ELEC. ILL'G CO. OF BOSTON.

High power factor. Low power factor would cause central-station machines to become overloaded before the machines reached their normal rated capacity. Low efficiency in machines receiving power would cause a loss to the consumer and not to the central station. C. D. WOOD, JR.

T 9. Does the average induction or synchronous polyphase motor take a balanced load?

Yes. J. F. DOSTAL.

Yes. G. F. WILLARD.

I have made many tests of induction motors and synchronous motors of the polyphase type, and will say that, taking everything into consideration, the balancing of the load is usually good. There are many cases, no doubt, where the balance is very poor, but I do not think that very much trouble may be expected from this cause in the usual case.

G. H., N. Y. ED. CO.

T 10. Is the maintenance of a single-phase motor any more troublesome or expensive than that of the average direct-current motor?

Yes. W. H. GREENSLIT.

No; not so expensive as the direct-current motor.

F. C. S., MALDEN ELEC. CO.

No. G. F. WILLARD.

No; not so much so. J. F. DOSTAL.

The single-phase alternating-current motor is much less trouble and entails considerably less cost for maintenance than the average direct-current motor. G. WILBUR HUBLEY.

No. DOUGLASS BURNETT.

Not so much so. J. T. COWLING.

The average single-phase motor has a larger maintenance cost than the average direct-current motor. This matter depends, however, largely on the type of motor in question. I have in mind one type of single-phase motor with which I have had considerable experience whose operation was largely a matter of good luck and chance. Between defective clutches, defective phase-splitting devices and defective armature-short-circuiting devices, something was always giving trouble. GEORGE HOWE.

Single-phase motors are much less troublesome.
THE EDISON ELEC. ILL'G CO. OF BROCKTON.

No, we do not find it so.
AUGUSTA RY. AND ELEC. CO.

The kind of single-phase motor now in general use seems to compare favorably with the direct-current motor in regard to maintenance and operation. C. C. GARTLAND.

The cost of maintenance of single-phase motor is less than that of direct-current motor. F. G. PROUTT.

It has not proved to be so with this company.
THE EDISON ELEC. ILL'G CO. OF BOSTON.

We have not found single-phase motors any more troublesome or expensive than the average direct-current motor. In fact the alternating-current induction motors do not require the attention that direct-current motors do. C. W. KOINER.

T 11. What is the best practice, from an engineering as well as from an underwriter's standpoint, in designing the service leads and the fuses supplying induction motors? Should the service wires and fuses be of such capacity as to handle a continuous 100-per-cent overload on the motors?

The best practice for motor-service wires is to install wires large enough to carry full load without excessive drop and fuse about 25 per cent overload. A good way is to connect compensator ahead of fuses and fuse for full load of motor.

H. N. Crandall.

Yes. G. Wilbur Hubley.

When starting, single-phase induction motors take approximately double the current that the horse-power of the motor calls for. Therefore, to avoid continual fuse-blowing and possible overheating of wires, install service wires and fuses to handle 100 per cent overload. Warren Partridge.

Yes. Compensator-started motors take four times full-load current at starting.

The Edison Elec. Ill'g Co. of Brockton.

The fuses should not be of sufficient capacity to carry a continuous average overload of 100 per cent unless it is known to the operator and he has some reason for taking the risk. However, 50 per cent overload is permissible for a couple of hours or so. C. W. Koiner.

The well-known overload capacity of the induction motor must be considered in designing service leads and fuses. This overload capacity, however, can be and should be, limited by the fuses, which should be proportioned to protect the leads rather than the motors. If the leads are designed to carry current to the extent of 30 per cent in excess of the rated capacity of the motor, we have taken care of all starting or accelerating inrush that the motor requires under normal conditions.

This overload capacity of alternating-current induction motors has been referred by the National Board of Fire Underwriters to a special committee that is expected to report shortly. Rules governing this condition from their standpoint will undoubtedly be published, therefore, in the next edition of the Code rules. A. A. P., N. Y. Ed. Co.

All wiring and fuses installed in connection with induction motors should be of sufficient capacity to carry twice the normal full-load current of the motor.

THE EDISON ELEC. ILL'G CO. OF BOSTON.

T 12. Is there any way to prevent throwing of oil from an oil ring bearing, especially on small motors and generators under 15-hp and more particularly under 5-hp.

After especial observation of this point for a considerable time, the statement can be broadly made that not five per cent of the machines observed were free from this trouble on one or both bearings, to such an extent that very frequent filling of the oil reservoirs was necessary. In the cases more particularly observed the trouble frequently ceased for a time, and often would stop on one bearing and begin on the other for no apparent reason.

The most reasonable explanation of the cause has seemed to be that it is due to air currents which draw the oil out as it is passing the openings while it is in a finely divided state as thrown from the oil grooves of the shaft.

With enclosed types of motors it is often possible to use on the outside end a cap packed with felt which rubs on the shaft and removes all oil which tends to creep along the shaft by capillary attraction, but this usually transfers the difficulty to the inside end and fills up the machine with oil which in a short time will result in repairs being necessary. H. I. FINCH.

Remove part of the oil; the probabilities are that bearing is too full. W. H. GREENSLIT.

If bearing is properly constructed and oil is kept at its proper level, there ought not to be any oil thrown. See that the rings travel properly and that bearing is clean. If this is not the fault, try lowering the oil in reservoir.

A. PETERS.

Use a heavier grade of oil. D. CLINTON SHAIN.

If there is any room in which to do it, increasing the diameter of the rings will obviate it, the trouble being caused by rings revolving too fast, due to the nearness in size to the shaft.
C. F. HAYWOOD.

If bearing is a loose fit, there will be a tendency for oil to be forced out of the ends. If ends of boxes touch shaft, there will be a tendency for oil to siphon over, and to drip on inside of pulley, from which it is thrown. Should there be sufficient room between end of box and end of bearing to put a leather ring on shaft, this will prevent the oil from creeping further, as it will collect and be thrown from any diameter greater than shaft itself. CHAS. H. PETERS.

Cut a groove around the shaft, close to bearing, making it nearly perpendicular on the bearing side, with considerable slant on the opposite side. The centrifugal force will tend to throw the oil off the shortest way, hence up the steep side into the bearing. THE COLORADO SPRINGS ELEC. CO.

T 13. Are the individual motor-driven refrigerating devices now on the market practical from a standpoint of economy and profit to central stations?

Probably; though the best use of electric power should be obtained on machines from five to twenty tons per day capacity.
DOUGLASS BURNETT.

The development of electrical refrigeration in New York city and in other large cities is positive evidence that it is entirely successful in every way. From the standpoint of the central-station manager it is a most desirable load, as it is probably more uniform and constant than any other power load. A refrigerating machine of 10 horse-power usually brings as much revenue, due to the length of time per day during which it is operating, as a 100 horse-power installation in many other industries. From the standpoint of the consumer, it is very expensive to operate a small plant both night and day. Not only is such a plant expensive owing to its small size, but also to the fact that a double and often a triple shift of men must be employed to operate it; also because its constant operation and the consequent strain on the machinery causes frequent breakdowns and a large repair account. It is my opinion that electrical refrigeration is one field in which the consumer and the company will find much that is mutually attractive.

G. H., N. Y. ED. CO.

Individual motor-driven refrigerating sets are giving good satisfaction in apartment houses, drug stores, saloons, dairies, butcher shops, groceries and for special work in many industries requiring constant low temperatures. The writer has never heard of a single case where they failed to give satisfaction to the customer. As the cost to him is less than with other apparatus, and as the load is a long-hour one and a maximum in summer-time, it is certainly a very desirable business for central stations. THE PHILADELPHIA ELEC. CO.

There are motor-driven refrigerating devices on the market that are perfectly practical, both from a standpoint of economy and of profit to the central station. The load is a most desirable one, as it is never on the peak except in the case of meat markets, *et cætera,* which require more or less refrigeration all the year round, and even in such cases arrangements can generally be made to keep them off the peak. H. T. HARTMAN.

T 14. Are there any electric-light stations that are furnishing current for motors operating water-works pumping plants situated at a distance from the station, and with what success?

We have just installed a General Electric form K, three-phase, 2300-volt, 50-hp induction motor to operate a centrifugal pump for the Ralph Beaton Water Company of this city. This pump is situated at a reserve reservoir about two miles from the main pumping station. There is no attendant at the station where the motor is located. The motor is started from the main station, an ammeter indicating whether or not it comes to speed properly.

Immediately after installation heavy rains made its use for the present unnecessary, so we can not say how long it will operate successfully, but if party asking this question will communicate with us some months from now we will gladly give him the benefit of our experience. W. H. THOMSON, JR.

The DeKalb-Sycamore Electric Company furnishes current for motors operating water-works pumps, situated at a distance of about 2000 feet from the station, with excellent results.

The transmission lines are arranged so that the motors are controlled from the generating station. The motors and pumps are run without an attendant for 24 hours each day, more or less, except that an attendant visits the pumping plant twice each day and puts in about one hour at each visit in caring for the machinery. W. H. ZIMMERMAN.

We are working satisfactorily two water-works pumps on 500-volt railway service. AUGUSTA RY. AND ELEC. CO.

T 15. (a) Is it good practice to use motor-driven pumps for city pumping for a standpipe system in a town of from 3000 to 5000 people? (b) Which are the best adapted, gear plunger pumps, duplex pumps, or turbine pumps? (c) What would be the cost of installation, also rates per kilowatt-hour for which it could be done to show a profit in a 24-hour plant?

No, unless some other power is available for immediate use, as lightning might start a fire in the town and put the electric service out of commission; at the same time it would be very risky. J. T. COWLING.

This question has been taken up and considered so many times, and results from such consideration have been so varied that little more can be added that is new. It is my opinion, that the triplex pumps would give better service. GEORGE HOWE.

T 16. What is the best way to handle elevators on alternating-current system having small units and light load?

Belted elevators, so arranged that the elevator can not be started until the motor is up to speed. G. B. LELAND.

Friction cone pulleys can be used.

G. Wilbur Hubley.

The best way is not to have direct-connected elevators on small alternating-current units, as they will affect the voltage, even with the best regulation on the machine.

(Unsigned.)

The operation of an electric elevator on a system such as mentioned is apt to be troublesome at the best, unless it can be taken care of on a special rotary-converter system, the elevator motor to operate at 240 volts, direct current. The best type alternating-current motor available, on the market, is either the type M General Electric or the Crane type Westinghouse.

The repulsion type of motor, which is now being developed to a high state of efficiency, is well worth investigating for this class of service. A. A. P., N. Y. Ed. Co.

Probably tight and loose pulleys will be the best.

Augusta Ry. and Elec. Co.

The best way to handle elevators on alternating-current system is to run separate power circuit from the generating station, and if the station is equipped with polyphase generators, run this power circuit polyphase, using polyphase motors on the elevators, which system is now entirely satisfactory. If the station is equipped with single-phase apparatus, single-phase motors are now on the market that would take care of the business equally as well as either three-phase or direct current.

F. G. Proutt.

T 17. What is the energy consumption per car mile of high-speed, hydraulic, electric-driven elevators?

Motor-driven pumping outfits cost for current from three to nine times the cost for direct electric elevators. In one case it is claimed that motor-driving hydraulic elevators is cheaper than steam-driving; in another, the cost of electric power for summer service when the boilers are not operating is as great as we would guarantee as a maximum for an entire year's service if the apparatus were replaced by direct electric. Figure five kilowatt-hours a car-mile for direct electric elevators. Elevators of 2000 pounds at 300 feet a minute may operate at three kilowatt-hours or less per car-mile.

DOUGLASS BURNETT.

The energy consumed by an electric-hydraulic elevator may be stated as about double that of the plain electric elevator. From the many tests that we have conducted, we will say that the cost of the electric-hydraulic elevator will range from five to eight kilowatt-hours per car-mile, depending upon its speed, capacity and type.
G. H., N. Y. ED. Co.

A number of tests on electric-hydraulic elevators show a consumption per car-mile of from 5.3 to 8.1 kilowatt-hours.

THE PHILADELPHIA ELEC. CO.

T 18. What has been the experience with motor-driven, two or three-stage centrifugal pumps in connection with electric-hydraulic elevators? (a) with direct-current motors and (b) with alternating-current motors?

The general experience of those who have tried this installation is that, where space is at a premium, the turbine pump may be used to advantage. This is the case at the 116th street station of the Ninth avenue elevated railroad. However, the efficiency of the turbine pump is much less than that of the triplex-force pump, and therefore under ordinary conditions the former is more desirable. I should say that the direct-current motor in either case would be preferable to the alternating current for operating the pump.
G. H., N. Y. ED. Co.

T 19. What measures should be taken to promote the sale of power to farmers for driving agricultural machinery?

Have central-station managers take up farming as a side line.
FRED B. SHARPE.

The establishing of lines of alternating-current distribution and individual transformers throughout the farming sections. Introducing a flat-rate principle of charging as low as possible, consistent with a fair return on the money invested.

C. D. Wood, Jr.

Sell motor equipment at cost as a starter. Don't add any tax in the way of high minimum charges. Advertise, and make a "demonstration" or public test. Douglass Burnett.

T 20. What advantages has the induction motor over synchronous motors?

Induction motors have advantage over synchronous motors of lower first cost, great saving in weight, floor space and cost of installation, as well as simplicity of operation and freedom from mechanical and electrical complications. The induction motor is in practice the simplest known piece of electrical apparatus and may be located almost anywhere and controlled from any convenient point on the system. It is common practice to suspend them in sizes up to 150 or 200-hp from beams of cotton mills, or other large manufacturing establishments, making practicable the utilization of the entire floor space for manufacturing purposes. Ralph D. Laxton.

See answer to question K 18. M. P. R., N. Y. Ed. Co.

Induction motor, except for the condenser, will stand more rough usage. Augusta Ry. and Elec. Co.

Starting torque high and adjustable, may be several times full-load torque. Motor can start with load.

Maximum torque at reduced speed, which shows excessive load.

Speed may be varied if necessary.

Simplicity of starting devices and absence of rheostats and instruments.

No necessity of skilled attendance to get best results.

Rugged and simple construction throughout.

No reaction upon generator and no danger of injury to motor in case current is lost through fuses, *et cætera*.

THE PHILADELPHIA ELEC. CO.

A few advantages of the induction motor over the synchronous motor are as follows: Simpler construction; greater starting torque; requires less attention; better line regulation on variable loads. GEO. H. JONES.

This is fully discussed in the *Electric Club Journal* of February, 1905. A. BALSLEY.

There is no comparison whatever between induction motors and synchronous motors in small units. The induction motor has a small starting current, does not require direct-current excitation and its fields do not have to be adjusted to meet varying conditions of load as is the case with the synchronous motor.

H. T. HARTMAN.

In general, the induction motor is preferable to the synchronous motor for the following reasons:

Simplicity of structure;
Simplicity of operation;
Not so liable to hunt;
Does not impress its own characteristics on the circuit;
Momentary drop in voltage not likely to cause motor to drop out and stop;
No exciter required.

The chief advantage of the synchronous motor is its power of affecting the power factor of the circuit by adjusting its field. The concurrence of so many factors are necessary for this, however, that good results in this direction are the exception rather than the rule. S. R. INCH.

T 21. Give some method for switching large synchronous-motor units to the supply mains, avoiding the use of starting compensator or separate starting motor.

This can be done by having the motor wound with two windings, which can be connected in series for starting and in parallel for running after the machine has attained synchronous speed. This would reduce the starting current, but the additional expense for the winding and the complicated switching required would more than offset the cost of the starting compensator. D. W. Roper.

T 22. How do small electrically-operated refrigerating machines compare in operating cost with ice, 300 pounds per day?

One manufacturing company proposes to install them for the amount of the ice bill. Douglass Burnett.

There are a number of electrically-operated refrigerating machines in practical operation to-day. In one make of this apparatus the electric motor is thrown on or off by a connection that is controlled through a thermostat. It has been found in New York city that these machines are less expensive in operation than is ice, the cost of the power consumed approximating $1.00 a ton while the additional items of cost are small.

S. C. Foster.

With ice at $6.00 per ton and current at 10 cents per kilowatt-hour the motor-driven machine will in this size save the customer from 35 to 50 per cent in dollars and cents, and will give him better and more exact results than he could possibly attain by the use of ice. These figures allow for interest upon the investment and that the life of the apparatus be fifteen years.

The Philadelphia Elec. Co.

U

METERS

U 1. What has been the experience with prepayment meters?

Quite satisfactory. W. H. Greenslit.

The experience of several users of direct-current prepayment meters has not been entirely satisfactory. The fault seems to be in the tripping device, and in consequence of this there have been discrepancies between the amount of money in the coin receptacle, the indicated use of current according to the meter register, and the dial showing the amount of current still to the credit of the customer. A. H. A., N. Y. Ed. Co.

Some of the largest gas companies are discontinuing their use. R. N. Kimball.

Prepayment meters are proving very valuable in building up a class of customers who have no financial responsibility, and, consequently, can not be handled by any other method than that of cash on delivery. In nearly every city of any size there will be found a large number of people of this class who are ready and willing to take the light if the local company will furnish it.

There seems to be a decided preference on the part of both customers and companies for using a unit coin of not less than 25 cents, as the customer frequently strenuously objects to making frequent trips to the meter, which are inevitable with smaller units. M. Carrington.

U 2. What effect have slot meters upon sales; have they reduced or increased sales?

They increase revenue. W. H. Greenslit.

Better put in a regular meter. Douglass Burnett.

See answer to question U 1. M. Carrington.

The company represented by the writer has found slot meters good pioneering devices for certain classes of business, where people are prejudiced against running up bills that have to be paid at the end of the month, or where their credit is not good, and they do not wish to put up deposits. When the slot meter has been perfected so as to overcome some of the present difficulties, notably the inability to change the rate, it undoubtedly will bring considerable business. John F. Gilchrist.

U 3. What satisfaction have slot-machine prepayment meters given; have they been found as efficient generally as the other meters? Assuming slot meters to be entirely satisfactory, would it be considered good policy to install them for any consumer who wished to be supplied with one, or would it be better to supply them only to doubtful consumers?

Supply any customer who wants one and persuade a doubtful customer to have one. W. H. GREENSLIT.

Note answer to U 1. There are several prepayment meters on the market, representing types of direct-current and alternating-current meters. The device is subject to the criticisms of the regular type meter, and, additionally, to inherent faults of the slot machine. Many customers of central stations in the East prefer monthly bills rather than the annoyance of attention to the device by both himself and the company's meter men. The largest field is unquestionably in apartment houses.

A. H. A., N. Y. ED. CO.

The prepayment device for meters has not been found as reliable as the meters alone. With a satisfactory device I think it would be good policy to install a prepayment meter for any customer desiring one, provided there be a guaranteed monthly income. O. J. BUSHNELL.

U 4. How can you satisfy the customer that his meter registers his consumption correctly?

It is impossible. F. C. S., MALDEN ELEC. CO.

The simplest and crudest way is to have your customer turn on, say, one lamp, and note the speed of the meter, then turn on another lamp and note that the meter's speed is doubled; three lamps, etc. This appeals directly to the eye and is often amply sufficient.

Where questions of considerable accuracy are concerned, however, the meter should be tested on the customer's premises under his own working conditions and, preferably, with his own load. This can be most easily done by means of another meter of known accuracy, by merely comparing the two. If the accuracy of this standard meter is questioned it then becomes necessary to test the standard meter under laboratory conditions.

E. W. GOUGH.

One way is to take the customer to the meter, explain as clearly as possible its action, tell him what current a given candle-power lamp is supposed to consume and what it will record on the meter dial for a given length of time. Then tell him to test the meter himself by burning a given number of lamps a certain period of time.

E. A. VAUGHN.

By explaining details, and taking pains to show him the working of the meter; show him how readily it will stop and start and have him take active part in test; be particular to show him that you are thoroughly honest in the matter, and that you are giving him especial attention; show him that jewel wear will make a meter run slow and the chances are that you will gain his confidence.

W. H. GREENSLIT.

Practical demonstration and tests should be convincing.

G. WILBUR HUBLEY.

It is often impossible to satisfy a customer that his meter registers correctly, but I have had pretty fair success in showing him how to read his meter, then explaining to him that at 16 cents per kilowatt-hour a 16-cp lamp will consume about one cent's worth of energy for each hour it burns, and letting him test it for himself. Customers are usually willing to pay a cent an hour for current to run a 16-cp lamp. I seldom find a lamp that consumes a cent's worth of energy per hour, but occasionally one will do so, hence I put the margin on a safe basis.

P. H. HODGES.

Have consumer turn on given number of lamps for a given time, show him how to read meter and figure bill.

FRED B. SHARPE.

Teach him to read his meter. If he is not then satisfied, take the meter to plant and test it with a standard. If he is still unsatisfied, measure the voltage of his lamps and teach him to figure the amount of consumption from the number of lamps and hours used. MADISON LT. AND RY. CO.

Know that your meter is correct.

Know the wattage of his lamps, then read the meter with him, and have him turn on a number of lights and burn them several hours. Then read the meter again; reduce the current consumed to lamp-hours, and have your customer reduce his record to lamp-hours, then compare figures. If you are careful, you will convert him. Don't pretend to come closer than five per cent. Mention variable voltage, irregular wattage of lamps, and other plausible reasons. ELBERT D. KELLEY.

To satisfy the consumer that his meter is registering his consumption correctly, you should know what the voltage of the circuit is at his residence. Test up some lamps of the same candle-power he is using on that voltage, tell the consumer what wattage each lamp should take, turn on 10 of them, then show him where the hands will point in one hour with 10 lamps on. As an example, suppose his lamps were 16-cp and they consumed 3.5 watts per candle-power on 100 volts. The wattage of each lamp would be 56 watts and 560 watts on all 10 of them. In one hour the meter will have recorded 560 watt-hours or .56 of a kilowatt-hour. If the dial reads in tenths of a kilowatt-hour, the first hand will have passed the 5 and .6 of the next division.

If a more accurate method is desired, it can be obtained by connecting a portable wattmeter in the circuit. Turn on a number of lamps, read the wattage indicated by the portable instrument, and tell the consumer how many revolutions the meter should make in 60 seconds on that wattage. If the meter makes that number of revolutions in less than that time it will be fast, and if it takes more than 60 seconds the meter is slow. If the meter should be a second or two fast, the consumer may think he is paying out considerable more money than he should; then you will have to show him what per cent fast his meter is and what it amounts to in dollars and cents. This can be done by using the meter-testing formula of the particular meter you are testing to find the wattage it is recording. The wattage of the circuit is already indicated by the portable wattmeter; this wattage is called the standard watts and the other the meter watts. Find the difference between the two wattages, then divide the standard watts into the difference and the result will be the per cent error. If the error is one per cent fast, the meter will be running at 101 per cent efficiency or recording one per cent more than it should, which would mean that the customer is paying one per cent of his bill too much.

J. B. MILLS.

By having customer present, and showing him that a 50-watt lamp will register 50 watts on meter in an hour.

THE COLORADO SPRINGS ELEC. CO.

The best method we have thus far found of satisfying a customer that his meter registers correctly, is to show him how to read his meter and induce him to make a trial with a certain number of lamps for a certain period, explaining to him how much those lamps should consume.

J. S. WHITAKER.

We show the customer the cost of burning one or more lights per hour, and at the same time we request the customer to check or count the hours lights burned per month, and to compare the result with bill rendered. This method is generally satisfactory.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

By having the meter tested by a competent and impartial outside party.

ELECTRICAL TESTING LABORATORIES.

Yes; I have done so with a portable ammeter and voltmeter.

FRED H. BECK.

After you have tested the meter and found it correct, show the customer how to read it, then both you and the customer get a reading. Get his average burning, say 10 16-cp at 56 watts per lamp, making 560 watts the total consumption per hour. Then tell the customer where the hand on the dial will stand after the lamp-hour test.

CLAYTON GEIGER.

Invite the customer to the testing department, and if he will not accept take an indicating meter to his house or store, and with a small bank of lamps you can show him how much of a load you are running, and can also test his meter. Show him that the meter does not run all the time. Shut off the lights and turn them on again, and do all in your power to prove to him that you are honest in the matter, and just as anxious to have the meter right as he is. H. E. RYDER.

Have him make a test with a certain lamp load, burning a certain length of time; or make a test for him, and go on record about the test. DOUGLASS BURNETT.

We have satisfied many customers by installing for four or five days each month at their premises a Bristol recording wattmeter, which would indicate the number of lights burned at different times and how long they burned. We would move this around and install at five or six heavy kickers' each month and take the charts to them and tell them positively, as the case might be, that they did have lights burning all night, and they would generally admit it and acknowledge that perhaps the meter was not overcharging them. W. H. THOMSON, JR.

We test the meter for the customer and tell him all we know about the operation of the meter and the test. We find that it is good policy to let the customer know all about the operation of the meters and when they are familiar with it there is less complaint. UNITED ELEC. LT. CO.

The more correct information a customer has about his meter and his service, the more easily he is satisfied; the less a customer knows the more difficult he is. Give him painstaking instructions how to read his meter. Show him how to test it by turning on one lamp, then another, then several, *et cætera,* up to full load. Show him that the meter will not "go round" when no load is connected. Take him into full confidence, show him there is no mystery about the meter or his service.

A most convincing way is to have fitted up in your office a meter with as much of the interior visible as possible, and so connected that any number of lamps, from one upward to full load can be connected or cut off at will. Invite the customer to your office to see the operation of the meter under the various loads and show him that it does not register without load.

Customers are not bothering, as a rule, about one per cent or two per cent; usually their complaints are "twice too much," *et cætera.* Instruct all meter readers, clerks and employees who meet customers, to tell them all about the meters, how to read them and how to make the simple test of noting the difference in rate of speed of the disc with one lamp, two lamps, and up to full load. In the great majority of instances the customer will learn that the meter, by being slow, favors the customer instead of the company. W. W. TITZELL.

Take the meter down and show him, by testing it in his presence, as almost any person with common sense can understand the simpler methods in use. L. E. WATSON.

Set up in his place a duplicate meter and connect the two to register the consumption separately. A. R. MACKINNON.

Tell your customer what it should cost him per lamp-hour; *i. e.,* 0.25 cent, 0.5 cent or one cent per hour per lamp. Read meter and ask him to keep accurate count of lamps used and number of hours burned for a certain time (one or two days), then read meter, figure amount due you, and tell him. If meter is correct you will have no trouble in satisfying the average customer. ANDREW F. HALL.

Several methods can be employed to convince the customer that his meter registers correctly. One of the most common is to have either the customer or else an inspector of the company make a lamp-hour test of the meter, thus demonstrating that the instrument is simply recording the actual current consumed.

Another method is to test the instrument in the presence of the customer by the regular voltmeter and ammeter method. This, however, should not be resorted to unless the customer has some knowledge of or confidence in what is being done. The third method is to test the meter in question with a standard meter placed in series with the same. The customer's attention can then be brought to the fact that the instruments are running together and that his own meter is recording correctly. It is sometimes well to install recording ammeters, as by so doing the customer can be shown the approximate number of lamps in use, the number of hours in use, and at what time during the day or night these lamps are burned. This method often convinces the customer that his meter is simply indicating the actual use of the service. W. R. B., N. Y. Ed. Co.

Careful test or comparison in his sight with standard meter.
Augusta Ry. and Elec. Co.

Have him bring his electrician to your testing-room and see it tested and then installed on his premises.
E. A. Bechstein.

The best way to satisfy a customer that his meter registers correctly is to visit his premises when he is at home, explain to him carefully the operation of the meter, tell him what it would cost to burn a 16-cp lamp per hour at the rate he is paying and show him how he can read the meter and check the consumption of one or more lamps for a given length of time against this reading. A little time spent in this way will be very beneficial to both the customer and the company.
F. G. Proutt.

We have found it very satisfactory to tell a customer the number of watts that each lamp uses, and have him keep a record for a month of the number of hours that his lamps are used. We then compare the reading of our meter with his report and generally find it works out very closely. For example: We told a customer who had an electric sign that the cost of the sign would be about twenty-seven cents per hour, on a meter charge of ten cents per kilowatt-hour. The customer placed in a box set apart for the purpose twenty-seven cents for every hour he used the sign. At the end of three months he told us that he had five cents more in the box than we charged him on the meter reading. E. F. McCabe.

In most cases a customer is satisfied as to the accuracy of his meter by a test made on the premises in the presence of himself or of an expert representative. When the customer still doubts the correctness of his bills, we have proved them conclusively by putting an inspector on his premises for from one to three days, to take a record of the light used by 15 to 30-minute counts of the lamps burning. Even when the use of the light varied considerably during the day, the count would check within five per cent of the meter reading. O. J. BUSHNELL.

By testing the meter with a standard integrating wattmeter in the customer's presence. Explain the method of testing, and if he then questions the accuracy of the test by doubting the correctness of the standard meter proceed as follows: Direct him to turn on a certain number of lamps unknown to you. Count the revolutions of the disc for a period not less than three or four minutes, keeping the time precisely by means of a stop-watch. The load on the meter can then be easily reckoned in the regular way by multiplying the number of disc revolutions by the meter constant and dividing the result by the time in seconds. Reduce the watts recorded to terms of 16-cp lamps. Repeat this "blind" test on loads varying from one or two lamps up to about the full capacity of the installation—say four tests—and the customer will see that his meter is after all a very accurate instrument. (UNSIGNED.)

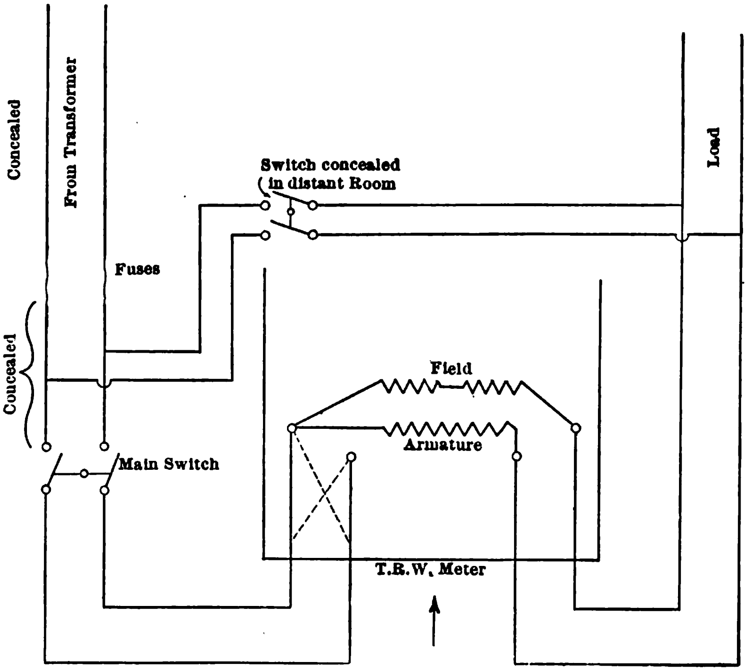
Start a campaign of publicity on the meter question; send out pamphlets giving instructions for reading meters and for making approximate tests for their accuracy; encourage your customers to read their own meters and compute their bills. Such a course has a good effect in showing the company's fairness, and "kicks" will decrease as the meter becomes less a mystery to the customer. S. R. INCH.

U 5. What effective means, if any, have been found to make it impossible for a customer to beat a recording wattmeter, or what special precautions can be taken by an electric-light company to detect same?

Have both leads run into meter with shunt connection under case. Meter sealed securely. G. WILBUR HUBLEY.

Place a meter on the service pole for a month or two, and he will soon find out you know what he is doing. J. F. C.

The accompanying diagram will show a case I once found and its remedy. Customer had concealed wiring in house and only main-line cut-out and meter loops were exposed. Remedied this by crossing wires in meter according to dotted lines, and sealing meter; consequently, when he had closed both concealed and main-line switch it would blow fuse. Even though this left a chance for him to beat the meter, yet in a quiet way it informed him that we were familiar with it.



W. H. Greenslit.

Keep your meters sealed, and in wiring do not allow the main cut-out and circuit blocks to be put too close together; in my system of wiring, one is in front, and the others behind meter. A meter man should study character; if things are suspicious go at unusual hours for inspection or reading.

Elbert D. Kelley.

I think that there is no effective means to make it impossible unless all wires, from where they enter the building to the load side of meter, are under lock and key. We find that by using glass cases on meters this trouble is eliminated considerably.
F. C. S., MALDEN ELEC. CO.

I do not know of any way to make it impossible for a customer to beat meter, but precautions can be taken by making regular and frequent inspections.
THE COLORADO SPRINGS ELEC. CO.

Put a strongly made wooden box, with inside screwed hinges, close to service end. Run service wires directly into box, or use iron pipe if not possible to locate box there. Have the neutral run through solid—without fuse—and locate closely-rated enclosed fuses in box *after meter*. This arrangement will prevent customer from purposely blowing one service fuse on the side from which meter takes its potential, and then burning half (or by bridging over all) his lights without any registration. Box must be three inches larger than meter, to prevent external magnets being used to create strong stray field. Inside of box should be painted black, so that small drill-holes will be conspicuous when inspecting meter. Use a good Yale padlock, and obliterate the maker's key code, which is stamped on side. Keep track of customer's consumption and if it does not check out examine meter *at night*. G. R. RADLEY.

A device has recently been patented by W. W. Fuller, superintendent of the Charleston (S. C.) Light and Power Company, which is intended to cut off the lights in a building if the meter is tampered with or if the shunt circuit is broken. The device has not yet been put on the market, so far as the writer knows, but seems to have the elements of a satisfactory apparatus for this purpose, and it is only a question as to whether or not the cost of the device, if it should be made, would justify any company in adopting it. The number of Mr. Fuller's patent is 782,386, of February 14, 1905. R. C. LANPHIER.

Have your meter men and inspectors keep their eyes open, especially on certain questioned premises, or on certain classes of questionable premises. Get your meter as near to the service as possible. DOUGLASS BURNETT.

The most effective means to prevent customer beating meter are: First, an all-glass instead of a metal cover, as the latter can be drilled and a piece of wire inserted to stop the disc; second, connections of both legs of circuit through meter, so that cutting one leg will prevent the flow of current; third, enclose the meter and connections in a locked box, inaccessible to any one except the holder of the key; fourth, have inspector examine carefully and frequently all connections and lines from main cut-out to prevent bridging. W. W. TITZELL.

Careful inspection and systematic testing at least once a year and checking up load, will locate possible sources of loss.
AUGUSTA RY. AND ELEC. CO.

We do not know of any effective means to make it impossible for a customer to beat a recording wattmeter. Even with meters of the sealed type with internal connections for the service and house leads, an occasional case may be found where there has been a deliberate attempt at theft of current. The precautions should be a very careful system of examination by inspectors, meter readers and meter testers, examination of seals of the meter, wiring, and service conditions. A. H. A., N. Y. ED. CO.

The question of proper protection to service and meter appliances is one that will ever be important to lighting companies. There is no system of surveillance that can be relied upon to detect all cases of interference. If a customer's account decreases suddenly the bookkeeper should advise an investigation; likewise, all inspectors, meter readers, meter testers—in fact, all persons connected with the lighting company and visiting customer's premises should instantly note any irregularity and report same to the office. The value of a good detective force will be appreciated here, for it should be their duty to follow up the case, detect, and if necessary secure the conviction of the guilty parties. E. A. N., N. Y. ED. CO.

When a customer is suspected of attempting to beat his meter let him know indirectly that you are aware of it. When taking the regular monthly reading look over the wiring around the meter for evidence of tampering. Test the meter a few days afterwards on his premises. Take the index every other day for a week. This procedure will make him very wary of attempting to repeat his operations. (UNSIGNED.)

U 6. What percentage variation from no load to 50 per cent overload should be allowable on consumers' meters?

No percentage of variation can be given for no load. It is customary in good practice to take some percentage basis as light-load point, at which the meter must possess a certain degree of accuracy. This percentage represents a percentage of the meter's rated capacity. Ten per cent load is being generally adopted by the larger companies as being the light-load point where a certain degree of accuracy is necessary. A good modern meter should not show an error, plus or minus, exceeding two per cent from 10 per cent load to 50 per cent overload.

E. W. GOUGH.

Two per cent on two per cent of load to two per cent plus on full load, is a reasonable allowance, as practiced by some meter builders. P. H. HODGES.

On commutator meters five per cent from no load to 10 per cent load; two per cent from 10 per cent load to five per cent overload; on induction meters they should maintain one per cent from no load to five per cent overload.

THE COLORADO SPRINGS ELEC. CO.

Two per cent. CHAS. H. PETERS.

Not to exceed two per cent above or below accuracy.

G. WILBUR HUBLEY.

The requirements as to the permissible variation from no load to fifty per cent overload on consumers meters, vary in different places, but as a general rule no meters should be left in service without recalibration which show a variation greater than plus or minus three per cent from a reasonable starting load, according to the size of the meter, up to fifty per cent overload after the meter has been in service say three or four months. A reasonable starting load within which the meters should be held to this accuracy, is, say, five per cent of full load. Of course all meters should start and record freely on less loads than this, but from the experience of many stations this has been found to be a fair percentage of the full load at which to hold the meter within the three per cent limit. R. C. LANPHIER.

Variation allowable should not be considered on less than one 16-cp-lamp load. Variation three per cent, plus or minus, should not be exceeded at from ten per cent to full load.

W. W. TITZELL.

The degree of accuracy of a meter at any load is subject to the laws of the state or other recognized authority, as well as to physical conditions. The tendency of most meters on a very light load, and on overload, is to run slow, especially if the meter has been in service any length of time. It is generally conceded that commercial conditions require the curve of the meter from no load to 50 per cent overload to be within two per cent plus and two per cent minus. A. H. A., N. Y. ED. CO.

Not more than six per cent. (UNSIGNED.)

U 7. If a meter is found creeping forward, is it advisable to grant the customer a rebate?

Yes, if customer is being seriously overcharged thereby, or in any case if a complaint is made. The average customer will be favorably impressed by the company's honesty. W. H. C.

Yes; it inspires confidence. FRED B. SHARPE.

Yes. Change meter, and allow rebate on off-state reading.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

If a meter creeps and probably has been creeping for some time, justice to the customer demands some sort of rebate, but policy should determine the nature of the rebate.

GEO. B. LAUDER.

Yes, grant him anything if he has seen the meter creep. But find some defect in the house wiring—a ground, or something—and when you have adjusted the meter show him that it does not creep; don't lay it on the meter. ELBERT D. KELLEY.

If a meter is found to be creeping forward, it is probably due to weakening of retarding magnets, which should be readjusted. It is seldom advisable to grant customer a rebate, as, if you do so, he will tell others, and in this way stir up a hornet's nest—every customer's meter will be running fast.

CHAS. H. PETERS.

It is well to grant a rebate, but let the customer assume that it is on account of the meter being over-read, or a ground in the house, or some other cause, as he is liable to tell all his neighbors that their meters are creeping, which will entail a lot of unnecessary work for the testing department.

THE COLORADO SPRINGS ELEC. CO.

Yes, provided it can be done in a manner not to arouse his suspicions about meters. W. H. GREENSLIT.

Yes. F. C. S., MALDEN ELEC. CO.

Rebate can be made on basis of estimate, and such defect should be corrected. G. WILBUR HUBLEY.

Yes, when the question is brought up. This is likely to be much overbalanced by the tendency of the meter to operate at less than 100 per cent efficiency. DOUGLASS BURNETT.

It is not advisable to tell the consumer his meter crept; give him a rebate, but on some other basis. There is a popular idea that electric and gas meters work all the time, and it is not a good thing to foster this idea. A. PETERS.

No. The amount of overcharge would probably be very small; an acknowledgment that your meter was fast would soon be a matter of discussion among a good many of your other customers. A. R. MacKinnon.

Be honest, and give the customer his dues.
L. E. Watson.

Certainly, rebate for forward creeping meter, but remove such meter at once. W. W. Titzell.

Certainly. Keep him satisfied if possible.
Andrew F. Hall.

If the meter is creeping forward and the customer finds it out, give him a rebate, as it is coming to him. If the meter department has things very nearly right, you will be bothered but very little on account of this fault. H. E. Ryder.

No. Any suggestion that tends to give the customer the faintest idea that a meter is not absolutely accurate is very bad business policy.

Creeping can be obviated by attaching to the disc of the meter a small slip of metal, which will be just enough to prevent creeping, yet not enough to retard the legitimate movements of the meter. The Edison Elec. Ill'g Co. of Brockton.

If a question has been raised regarding the accuracy of a charge and a test shows the meter to be creeping, it is certainly advisable to make the proper allowances for this creeping, should it effect the bill to any considerable extent. In fact, if the creeping is considerable, it is well to adjust the charge by consultation with the customer, as it is somewhat difficult to arrive at the actual amount over-indicated by the meter in this manner, as the speed of creeping varies considerably with the variation in vibration. W. R. B., N. Y. Ed. Co.

Yes, because the argument is entirely in the consumer's favor. E. A. Bechstein.

A customer should be allowed a rebate for creeping, whenever it affects his bill materially. O. J. BUSHNELL.

If the amount is found to be appreciable it should be allowed.
AUGUSTA RY. AND ELEC. CO.

Where a meter is found creeping same should be tested for the amount of error and a rebate granted for the time that the meter is known to have been creeping. C. W. KOINER.

Whenever a meter is found incorrect and registering more than the customer is using, whether the fault be due to creeping or other causes, allowing, of course, a margin of, say, two per cent either way, the customer should be rebated, whether he knows the meter is wrong or not. F. G. PROUTT.

No. Change his meter for one that does not creep. Explain to him that the creeping has been effective only during the hours that the meter was idle and that the result of the creeping during the month has an insignificant money value.
(UNSIGNED.)

Yes. J. W. COWLES.

U 8. What will be the effect on a 16,000 alternating meter to have 15,000 alternations or 17,600 alternations at the generator?

The characteristics of the type of meter in question will determine its accuracy under changes of frequency, provided it is an induction wattmeter. Due to the increased number of alternations from 16,000 to 17,600, the majority of induction wattmeters on the market at present will tend to run a little slow on the higher frequency when the load is non-inductive; if the load is inductive, however, most meters have a tendency to run fast. E. W. GOUGH.

My opinion is that a meter calibrated for 16,000 alternations would have a tendency to run slow with 15,000, and the reverse with 17,600. P. H. HODGES.

It will probably creep. W. H. GREENSLIT.

No appreciable effect; it depends entirely on the make of meter. F. C. S., MALDEN ELEC. CO.

Fifteen thousand alternations will make meter run fast, and 17,600 will make it run slow.
THE COLORADO SPRINGS ELEC. CO.

Most makes of meters will run practically correct on such changes of frequency. The frequency will be exactly the same at the meter that it is at the generator. DAVID W. BEAMAN.

Should not have any material effect from such variation as noted. G. WILBUR HUBLEY.

All of the induction type alternating meters now on the market are so constructed that a difference of 100 alternations above or below 16,000 on a high-frequency meter, should have very little appreciable effect on the accuracy of the meter. All of the manufacturers of meters of this type list them for a range of about 115 to 140 cycles for the high frequency.
R. C. LANPHIER.

Induction wattmeters on non-inductive loads tend to run slow on higher frequencies and fast on inductive loads.
W. W. TITZELL.

Depends largely on the type of meter in use. The tendency will be for induction meters to run fast as the frequency is lowered and to run slow as the frequency is raised from that for which the meter is designed. Good meters, however, allow considerable variation in frequency without affecting the accuracy.
J. W. COWLES.

U 9. Why does a very slight jarring continuing about 12 hours out of the 24 cause a meter to run gradually slower and slower, and how can it be remedied? The meter has to be replaced about once every ten months.

The vibration causes damage to jewel-bearing of meter. The location of meter should be changed to remedy the trouble.

G. Wilbur Hubley.

The difficulty experienced is probably due to the wearing in the jewel and pivot, due to the pounding on the bearing resulting from the excessive vibration. E. W. Gough.

This is probably a commutator type of meter and jarring causes the brushes to spark, which burns brushes and commutator. This can be remedied by increasing tension of brushes slightly, which will cause meter to run slow on very light load. This will probably cause you less loss than does your present condition.

J. F. C.

The vibration increases the wear on jewels. Insert new jewels. Fred B. Sharpe.

Continued jarring of a meter with jeweled bearing causes the point to roughen the jewel, thus causing increased friction. Sometimes the pivot will drill a hole in the jewel, causing the meter to drag badly. The best remedy is to place the meter on a solid wall or partition, so that it will not receive the jarring.

P. H. Hodges.

On a commutator meter the jarring will cause friction at the brushes and commutator, which will continually spark, and sometimes cause a short-circuit in commutator. If an induction meter, the jewel has probably become worn. This can be remedied by testing and cleaning meters, renewing pivots and jewels, instead of replacing meter. The best remedy would be to change location of meter.

The Colorado Springs Elec. Co.

The slight jarring causes excessive wear of jewel and pivot. If it is a Thomson (commutator) type, most of the trouble is due to poor contact at brushes. We change meters subject to jar every three months, and in some cases oftener.

If alternating current, an induction meter would give better results. Charleston Consol. Ry., Gas and Elec. Co.

I should think that this jarring caused the jewel and pivot to become destroyed, which would naturally make the meter run slow. If this is a commutator-type meter, the vibration, jarring the brushes, causes them to spark and badly corrode the commutator, which would also cause it to run slowly.

F. C. S., MALDEN ELEC. CO.

If the meter is of the commutator type, the trouble is probably due to the roughening of the jewel and the sparking at the brushes, increasing the friction, thus causing the meter to run slower. P. C. MORGENTHALER.

It very likely causes jewel to wear unnecessarily fast.

W. H. GREENSLIT.

Slow running of the meter noticed is probably due to deterioration of the pivot and jewel, caused by the pounding action of the moving element. The obvious method to remedy this is to support the meter in such a way that it is not subject to jar. This effect should be smaller on meters that have light moving elements. ELECTRICAL TESTING LABORATORIES.

The continual jarring undoubtedly damages lower jewel-bearing and pivot, causing roughened surfaces, and in this way meter runs slow. Most modern meters have removable pivots and lower jewel-bearings, which can be quickly replaced for a trifle. It might be possible to reduce the trouble by mounting meter on rubber cushions. CHAS. H. PETERS.

If it is a direct-current meter, the jarring causes more or less sparking at the brushes, and increases the wear on the jewel.

DAVID W. BEAMAN.

It is probable that the very slight jarring mentioned, which causes the meter in this particular location to run gradually slower and slower, is due to the constant hammering of the pivot upon the jewel, and this is a very difficult trouble to remedy, the only practicable solution being to use a diamond jewel instead of a sapphire for this particular meter. Even this may not really overcome the difficulty, but if a meter under these circumstances has to be replaced once every ten months, using a sapphire jewel, it should last fully three times as long with the same accuracy on light loads when using a diamond jewel.

R. C. LANPHIER.

Move the meter to some solid support.

DOUGLASS BURNETT.

The end of spindle and jewel become worn through.

A. PETERS.

The jar causes the jewel and pin to become damaged, thereby increasing friction of the meter. Use a magnetic flotation, or place the meter in a place where the jar is not noticeable.

G. F. WILLARD.

Jarring causes the disc shaft to pound and wear the jewel, hence increase of friction, and meter running gradually slower and slower. Avoid jarring on the jewel, whether caused by the design and construction of the meter or otherwise.

W. W. TITZELL.

Vibration causes depreciation of accuracy through the wearing of the jewel and pivot, and also through sparking at the brushes. If no other location can be found where the vibration is at a minimum, it is advisable to install a cupped diamond jewel and slightly increase the brush tension.

A. H. A., N. Y. ED. CO.

Because of the jarring the rotating parts become worn in a short time, especially the jewel, and the meter should be placed where it will not be jarred. E. A. BECHSTEIN.

Wearing of jewel and brushes may cause this.

AUGUSTA RY. AND ELEC. CO.

The vibration causes roughening of the jewel and, consequently, the slowing down of the meter. Meter should be removed to a place free from vibration even if it has to be put on a pole in a box. C. W. KOINER.

It is probably due to the jarring of the meter shaft on the jewel which makes the jewel and shaft both rough and causes it to stick. If it is a commutator type of meter the jarring might have a tendency to cause sparking at the brushes, in which case corrosion and poor contact of brushes would make the meter run slow. F. W. BULLOCK.

Where a meter is subjected to a continuous jar, it can be mounted on a board that is hung by a coil spring and kept about two inches from the wall by large spiral springs made of No. 10 and No. 12 spring-steel wire. This will take up the sharp vibration and greatly increase the life of the jewel and brushes.
O. J. BUSHNELL.

The vibration damages the jewel. It will be cheaper in the end to change the location of the meter, preferably to the cellar, than to be compelled to replace the jewel or substitute a different meter so often. (UNSIGNED.)

Probably due to jewel trouble or to light brush tension. Put in a cupped diamond and increase brush tension if necessary.
J. W. COWLES.

U 10. How often should consumers' meters be tested?

Once a year is good practice. G. WILBUR HUBLEY.

Not less than once a year; large meters, two or three times a year. (UNSIGNED.)

We test them when the readings indicate that they are not running correctly. Some meters will run several years without great error, while others need attention in a few months.
P. H. HODGES.

This depends entirely upon the make of meter, whether it is a commutator type or induction type. A commutator type should be tested at least three times a year; for a good induction type meter, the writer thinks once in two years is sufficient.
F. C. S., MALDEN ELEC. CO.

Experience alone can tell this; occasional and continued tests on meters in various localities and a sort of general knowledge of the way in which meters act under local and varying conditions would seem necessary for determining this point. A new meter would need retesting after being out a few months, while if retested and readjusted it should run much longer, as it has arrived at a point of stability which it must always reach before being entirely reliable. GEO. B. LAUDER.

Meters should be tested once each year. In the spring or early summer is the best time for cleaning meters.
ELBERT D. KELLEY.

Every month.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Every six months. UNITED ELEC. LT. CO.

It depends on the size of the meter and how much it is used. A direct-current meter should be tested every nine to twelve months, and twice as often if it is a large meter and used very much. An induction meter should be tested every twelve to eighteen months. DAVID W. BEAMAN.

Twice a year if commutator type; once if induction type.
THE COLORADO SPRINGS ELEC. CO.

Meter should be tested twice a year, also be inspected.
CLAYTON GEIGER.

Annually for regular meters, and tri-monthly for meters of large customers. DOUGLASS BURNETT.

Once every year, unless they show signs of trouble before the period is up. A. PETERS.

It depends on the kind of meter used, how often customer's meter should be tested. Meters like the one mentioned in question U 9 should certainly be tested more frequently than once every ten months; meters free from vibration, wear of jewel, or of commutator, in which friction does not increase, might be tested once a year for record purposes. W. W. TITZELL.

It is very poor practice not to test a meter at least once a year for all purposes, while meters operating under some conditions should be tested at least every three months. No definite period of time between tests can be given. E. A. BECHSTEIN.

There are so many influencing conditions that an inflexible rule can not be set. The type of meter has much to do with the interval between tests; direct-current meters of the motor type will be found to need more frequent tests and calibration than alternating-current induction meters; capacity, use as indicated by the number of revolutions of the motor, vibration, and dirt, are also to be taken into consideration. Larger companies are now testing generally on the yearly basis with subdivisions according to the above, at intervals of one month and upward.
A. H. A., N. Y. ED. CO.

Every twelve months. C. W. KOINER.

Six months to one year, according to type of meter.
AUGUSTA RY. AND ELEC. CO.

We have found it advisable to test commutator meters every three to twelve months; the frequency of the test depending on the size of the bills, the size of the meter, and the conditions of running and installation. Induction meters we test annually.
O. J. BUSHNELL.

The meter of a small consumer should be changed once in every year or eighteen months, as the revenue derived from him is from the operation of his meter on light loads. Inaccuracy appears on light loads before the meter varies from its full or half load correctness. It is advisable to change the meter instead of merely testing it on his premises, as the almost inevitable recalibration can be much more satisfactorily done in the station laboratory or testing-room. (UNSIGNED.)

At least once a year. F. W. BULLOCK.

As a general rule, every one million revolutions.

J. W. Cowles.

U 11. What is the best method of caring for meters; should they be carried to a test-room for repairs and calibrating, or should they be calibrated in place?

I think it best to remove a meter as soon as it shows any serious error, and replace it with another, then remove and calibrate in a room calculated for that purpose. As a rule, customers are suspicious that the lighting company intends to make meters run faster as soon as the inspector appears and begins to repair or clean them. The customer is usually better satisfied if told that his meter is defective, and that it is the intention to remove it and replace it with one known to be correct, than if the inspector proceeds to correct it on the premises.

P. H. Hodges.

Should be calibrated in test-room. W. H. Greenslit.

They should be calibrated in place, provided there are no extensive repairs to be made on same.

F. C. S., Malden Elec. Co.

We have tried both methods and prefer to bring our meters into the testing-room. Geo. B. Lauder.

Meters should be calibrated on consumer's premises, as it enables the company to find any lights that are not on meter and discover any shunts that might cut out part of the load. It also allows meter to be tested under working conditions, which is very important. The Colorado Springs Elec. Co.

It is best to calibrate a meter where it is installed. This eliminates the danger of changing the calibration in transportation. David W. Beaman.

If meters need repairing they should be carried to test-room where they can be given proper attention; if calibration only is necessary, it should be done on premises.

Clayton Geiger.

In all cases of repairs or recalibration meters should be brought to test-room of station. G. WILBUR HUBLEY.

Calibrate in place whenever possible.
F. ELLWOOD SMITH.

Should be brought in and repaired and tested, because it is almost impossible to test and repair meter with any degree of satisfaction on the consumer's premises. G. F. WILLARD.

In place. W. H. C.

The writer finds that in most cases it is more convenient to test meters on the ground, taking an indicating wattmeter and a small bank of lamps. R. V. WEST.

Formerly, it was the practice to return meters to the laboratory for test, replacing same from the tested general stock. At present the large companies test meters in customers' premises, which results in confidence on the part of the customer in his metering device. By testing meters on customers' premises accidental local conditions, such as vibration, condition of use, *et cætera,* can be allowed for. The method is subject to criticism on account of error in wattage fluctuation, errors of instruments, personal error and a resultant accuracy less adequate. These variations, however, are usually within the limits of generally accepted "commercial accuracy," and this system is, therefore, preferable.
A. H. A., N. Y. ED. CO.

In place, unless requiring extensive repairs.
J. W. COWLES.

A competent man could test, adjust and inspect meters otherwise all right, far more quickly and cheaply in place, though they should once in a while be taken out for thorough overhauling. AUGUSTA RY. AND ELEC. CO.

The better method of repairing and calibrating meters is to remove them and take them into the meter department.
F. G. PROUTT.

Meters can be tested or checked satisfactorily on the consumer's premises, but should the meter need any repairs or calibration it should be taken to your testing-room.
E. A. Bechstein.

Can be cleaned and calibrated in place at less expense than they can be brought into the store-room. C. W. Koiner.

Meters should be calibrated in place, except that the initial calibration and any extensive repairs should be made in a test-room. O. J. Bushnell.

The practice of changing a meter and calibrating it at the station has several advantages over the method of checking it in service. Two men can work together to better advantage—one to remove the old one and set the one that has been recalibrated while the other man is testing, repairing, and recalibrating at the station the meters that have been brought in. The man doing the outside work need have no special meter knowledge beyond the proper connections and methods of hanging a meter. This allows the meter expert to devote his time where it is most needed.

A meter can be given a more thorough test in every way in the testing-room where the proper instruments, lamp banks, freedom from interruption, all favor the operator and he can test more meters in a given time than when obliged to carry his instruments, resistances, and other incidentals from place to place.

When a meter is given a meager test in service and found to be inaccurate, the necessary recalibration can be made even more satisfactorily than the test in the laboratory. It is much better, then, to obviate the need of a second visit to change the meter, by making one job of it and changing it in the first place. From the customer's point of view, also, it is desirable that the job be finished as soon as possible and a meter can be changed in much less time than it can be tested.

Unless, therefore, the customer asks it, or for some other special reason, the best method of caring for a meter system is to change the meters and do the testing and recalibrating in a place prepared for just such work. (Unsigned.)

In place. DOUGLASS BURNETT.

U 12. Should a specific charge be made for a meter test that customer has requested, when meter is found slow?

No; it should be a benefit to the company when finding a meter slow. CLAYTON GEIGER.

No. (UNSIGNED.)

No. W. H. GREENSLIT.

The writer thinks it is not good policy for a company to charge for meter testing, when a test is requested by the customer, where the meter is found to be slow.
F. C. S., MALDEN ELEC. CO.

Not unless there has been a clear understanding beforehand. We make a proposition to any customer who doubts the accuracy of our meters or our own testing to take meter down and box it in his presence—he to have the privilege of sending it to any reputable firm for calibration. If found fast, we will stand all expenses. If slow, or correct, the expenses fall upon him. We have not yet found one to take us up. CHAS. H. PETERS.

No charge should be made for any kind of a meter test when meters are owned by the company.
THE COLORADO SPRINGS ELEC. CO.

Make no charge. Show customers every courtesy in proving to them that their meters are registering correctly.
WARREN PARTRIDGE.

Make no charge for meter test; make your charge for current not registered.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

No; it is not advisable in any case to charge customers for meter testing, this work being essential as protection to supply company. G. WILBUR HUBLEY.

No. If the meter is found to be slow the company should be grateful to the customer for calling attention to the matter.
F. ELLWOOD SMITH.

No; thereby retain his good will. G. F. WILLARD.

No. Test the meter every time that the customer wants it tested, free of charge. G. B. LELAND.

No charge should be made. Test will be paid for in increased revenue. W. H. C.

A customer should never be charged for testing his meter, nor for any other work done for him that will result in making him better satisfied with the service rendered by the company.
F. G. PROUTT.

No charge should be made for a meter test made by the company. O. J. BUSHNELL.

No; as it makes the company look small in the eyes of the customer. C. W. KOINER.

No. DOUGLASS BURNETT.

We do not consider it advisable to make a charge for test of meters requested by the customers. W. R. B., N. Y. ED. CO.

It would be good policy to charge customer with amount meter was slow. AUGUSTA RY. AND ELEC. CO.

Certainly not. It is the business of the company to keep its meters accurate, and to charge a customer for its own negligence is, to say the least, poor policy. (UNSIGNED.)

U 13. What is the best method of testing Thomson recording wattmeters on the customers' premises? Is there any convenient portable device that can be used as a variable load in making such tests?

Yes, the Sangamo test is very good. W. H. GREENSLIT.

A most convenient method is to use a portable load box that will give different loads from 40 watts to 1500, using a portable recording meter with a dial that registers revolutions, which several manufacturers are now putting on the market.

F. C. S., MALDEN ELEC. CO.

Use an indicating wattmeter and stop-watch. A calibrated resistance or lamp bank may be used as a variable load.

THE COLORADO SPRINGS ELEC. CO.

When testing a Thomson recording wattmeter on the customer's premises, a portable millivoltmeter and shunt box is used to get the current of the circuit, and a direct-current portable voltmeter to measure the voltage. For a load a portable lamp bank can be used, and for regulation, a resistance or rheostat can be connected in series with three or four lamps. Instead of the portable lamp bank the consumer's light can be used, and a portable rheostat can be made up with two 50-cp incandescent lamps to connect across the line for regulation. J. B. MILLS.

The best method of testing meters is with an ammeter and voltmeter, using the customer's lamps for a load, as then the test is made under the actual working conditions of the meter.

A convenient portable device for a variable load is made of a bank of lamps enclosed by a light wood framework and provided with handles for carrying. LOUIS I. PORTER.

A satisfactory method, which I have been using, is a portable lamp bank of six 100-cp lamps, arranged to burn in series on 220 volts or in multiple on 110. CLAYTON GEIGER.

Use a registering standard wattmeter of known degree of accuracy in series with the customer's meter. Every station should have at least three such standards, of some known degree of accuracy, kept in accord by daily check. Any one of the three can be used on customer's premises to determine the conditions of customer's meter; both operating under same load conditions, and degree of accuracy of the testing meter being known by daily check with the other two standards, accurate results can be obtained easily and quickly. W. W. TITZELL.

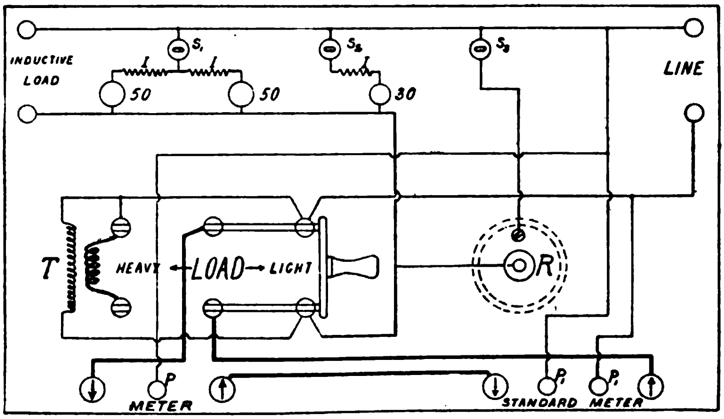
Turning on a few lamps on the customer's premises and observing the reading of the wattmeter with a stop-watch, and also noting the voltage makes a fairly reliable test.

THE EDISON ELEC. ILL'G CO. OF BROCKTON.

We consider the best method to use a standard rotating Thomson recording wattmeter of multiple-field type. This has been described at length in the technical press of the country. Several convenient portable devices for load are in use among the larger central stations, but these are not on the market.

A. H. A., N. Y. ED. CO.

Referring to the second question under this heading, would say there is a convenient and probable device now on the market that can be used as a variable load in making tests of alternating-current meters, either on the extreme premises or in the station. This device is called "The Sangamo Testing Set," being put up by the manufacturers in the form of a hardwood box, containing the various switching arrangements, rheostat, and transformer necessary for the operation of the set. The connections of the various parts are also shown on the diagram herewith. It is evident that the principle of operation of this testing arrangement, as described hereafter, can be used equally well for a regular testing rack in the station, in which case it is not necessary to have the parts so compactly put together, and various other controlling devices and attachments can be added if desired.



The testing set as made is designed for use with a standard indicating or integrating wattmeter and its purpose is to give a wide range of artificial loads under absolute control and with a very small expenditure of energy for the apparent heavy loads, these being obtained by means of a small special transformer.

For light loads, up to about 150 watts, a set of non-inductive resistances and a small water rheostat are provided, each resistance set being standardized for a certain wattage at any desired voltage. Thus, in the standard set there are two sets of resistances, one giving 100 watts and the other either 30 or 50 watts at rated voltage. The water rheostat is operated by means of a fibre knob passing through a water-tight gasket, and the rheostat has a range under control from about five to thirty watts, actual load.

On the switch-plate of the set are the three necessary snap switches, binding-posts, and a double-pole, double-throw switch, as indicated. For light loads, this switch is set in position marked "Light," all connections being then so that the resistances and rheostat give actual non-inductive load on the meter tested, the special transformer not being in circuit.

For large loads—above 200 watts—the switch is thrown over to position *heavy,* changing connections to the various parts of the apparatus. The primary of the small transformer is now in series with the resistances and rheostat, which thus become simply controllers for varying the pressure on the primary, giving a range of impressed e.m.f. from a few volts to the full line pressure. The secondary of the transformer, wound two or three volts maximum, and of large capacity, is at the same time connected directly to the series coils of the meter and standard wattmeter. These being of very low resistance, the full-load current will flow at from one-half volt to one volt pressure, according to the type of meter under test. Therefore, by varying the primary voltage on the transformer, the secondary voltage and current may be varied as desired.

The full line e.m.f. is kept on the shunt coils of the meter under test and the standard in both positions of the switch, however, and as phase relations are maintained correct, one obtains apparently large loads with the switch in *heavy* position with actually less power than is used for the resistances on light loads. For example, with any 5-ampere meter, 500 watts (full load) can be obtained by using the water rheostat alone, taking actually less than 20 watts from the line.

For inductive load, binding-posts are provided for connecting an arc lamp, motor or reactance coil, the main switch being set in "Light" position, as actual load must be used for this purpose. R. C. LANPHIER.

By using a standard portable integrating wattmeter, such as several of the companies are making. A convenient form of portable resistance for making such a test is a resistance coil wound in a tube. Each tube consumes 100 watts and they can be compactly mounted in a rack and connected so as to be readily cut in or out of the circuit when the load is to be varied. These tubes can be purchased. (UNSIGNED.)

A very convenient method for alternating-current plants is to use a Sangamo testing set; this apparatus consists of a number of non-inductive resistances by which the load can be directly varied from about 10 watts to 200 or so, and by means of a small current transformer, higher apparent loads up to 3000 watts can be obtained. The instrument introduces no inductive errors and weighs about fifteen pounds. S. R. INCH.

(a) It depends on size and kind of meter.
(b) Yes. J. W. COWLES.

U 14. What is the best way of keeping a meter record? This applies to the consumer's end of the service.

Use a card system giving name, address, number of meter, size, make, constant, date when installed and returned. Behind this, in same file, use a test card showing date and kind of test, whether it be a complaint, special, periodic, *et cætera*.
THE COLORADO SPRINGS ELEC. CO.

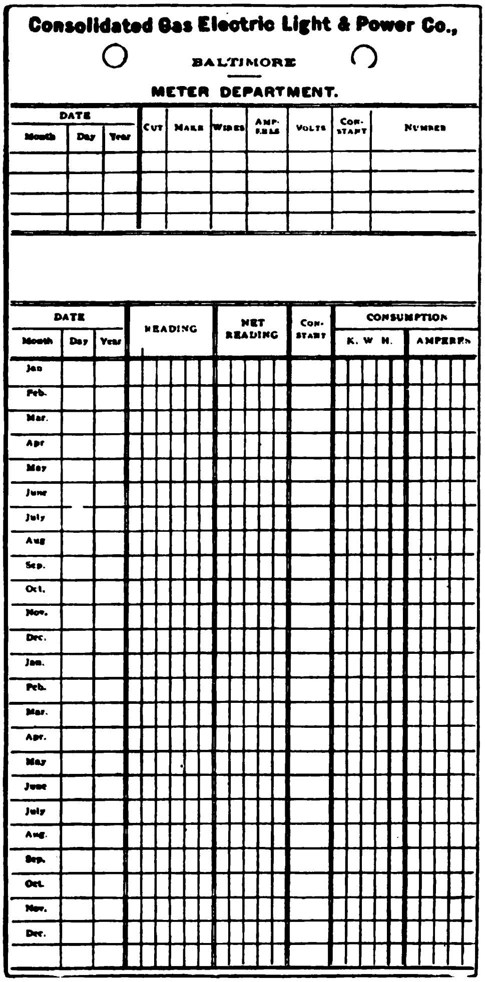
Have meter slips with dial faces on them. When meterman reads meter, let him mark on dial face of slip exactly how the hand stands on meter dial. Have a record book in which to paste each month's reading. CLAYTON GEIGER.

The company's books keep a record of consumption and a card for each meter should be arranged to keep a record of the meter with the number of revolutions it makes.

AUGUSTA RY. AND ELEC. CO.

We have found the best meter record to be an arrangement of the customer's reading cards according to street and number in loose-leaf binders, with a card index. O. J. BUSHNELL.

See meter-reading card enclosed. DOUGLASS BURNETT.



Consolidated Gas Electric Light & Power Co.,

BALTIMORE

METER DEPARTMENT.

Date			Cut	Make	Wires	Amperes	Volts	Constant	Number
Month	Day	Year							

Date			Reading	Net Reading	Constant	Consumption	
Month	Day	Year				K. W. H.	Amperes
Jan							
Feb.							
Mar.							
Apr							
May							
June							
July							
Aug							
Sep.							
Oct.							
Nov.							
Dec.							
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Oct.							
Nov.							
Dec.							

U 15. Are commutator-type recording wattmeters correct for inductive loads?

Yes. G. WILBUR HUBLEY.

No. W. H. GREENSLIT.

If calibrated on an inductive load they are correct, otherwise they are liable to be off from five to 10 per cent.
THE COLORADO SPRINGS ELEC. CO.

Commutator-type meters are generally accurate on inductive loads. P. C. MORGENTHALER.

Yes. CLAYTON GEIGER.

Commutator-type wattmeters are not correct for inductive loads, as they will invariably have a tendency to run fast on inductive load, due to a secondary torque that is developed when there is a difference in phase between the current in the series coils and the pressure current in the armature. There is no such condition existing in the properly constructed induction wattmeter, which is usually made so as to have a compensating arrangement that renders the meter correct on inductive loads of very low power factor. R. C. LANPHIER.

Yes; provided power factor is not lower than 0.75. If lower than this, a non-inductive resistance is usually placed in multiple with field coils. This brings current to phase with armature current. A. PETERS.

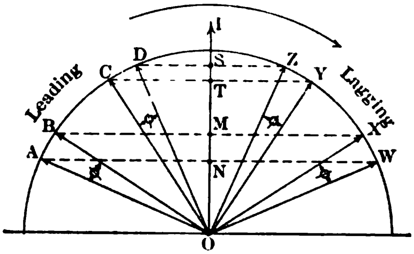
Sometimes. All can be made so by properly lagging the meter. We find it preferable, however, to use induction meters, giving a higher degree of accuracy after use for one year.
A. H. A., N. Y. ED. CO.

Commutator-type recording wattmeters have a slight error on inductive loads, unless ordered with a special correcting shunt.
O. J. BUSHNELL.

Yes. (UNSIGNED.)

Not unless lagged for inductive load. J. W. COWLES.

Not unless specially lagged for inductive loads. It is probable that most alternating-current plants now order induction meters so that what commutator meters they have are of the unlagged type. Such meters will run fast on inductive or lagging power factors and slow on leading or capacity loads, an error of five per cent to eight per cent being common when such meters are used on alternating-current arc lighting and similar loads. The error is due to the fact that the potential circuit of such meters possesses considerable inductance and the accompanying vector diagram shows why the error increases as the power factor gets lower.



Let *OI* represent the current in the series coils of the meter and *OY* and *OW* represent the voltage of the circuit for a high and a low factor, respectively. Let *OZ* and *OX* be the current in the shunt coil of the meter lagging behind the voltage by the same angle Φ by reason of its inductance. By projecting these values on *OI* it is evident that the lag of the shunt current (angle Φ) has a greater effect on low power factor than on high power factor and that in the case of lagging current, the meter will accord more than the actual load; a consideration of the left-hand part of the diagram will show that with a leading current the recorded power will be less than the actual power.

S. R. INCH.

U 16. What are the points to be considered in deciding what make of meter to use in order to get the best results?

The least complicated, and the one that takes up the least wall space, is easiest to calibre on various loads, with low shunt losses, large dials, least amount of friction, moisture, dust and bug proof. THE COLORADO SPRINGS ELEC. CO.

Some of the points to be considered in determining the best all-around meter for commercial work are—high ratio of the torque to weight; the design and finish of the bearing, if any; size of meter; weight of meter; ease of calibration and adjustment; ease in connecting in circuit; ruggedness—that is, the amount of knocking around it will stand; the amount of short-circuiting it will withstand without affecting its accuracy; permanency of permanent magnets; appearance.

E. W. GOUGH.

One that will run on light loads.
One that is easily adjusted.
One that is dustproof. FRED B. SHARPE.

A meter that will maintain its initial accuracy longest at the least expense; also meter that is simple in its construction and can be easily taken apart and reassembled without destroying its initial calibration. The first, of course, can only be obtained with any degree of accuracy by a two or three years' commercial test. F. C. S., MALDEN ELEC. CO.

Mechanical construction, *i. e.*, accessibility to parts; construction of rotating element; direction of vibration on disc or cup; substantiality of damping magnets and torque per unit of weight of rotating element. W. H. GREENSLIT.

Accuracy, reliability and durability. G. WILBUR HUBLEY.

(1) Minimum friction; least possible contact of moving surfaces.

(2) Minimum increase of friction.

(3) Sufficient torque to overcome maximum increase of friction without being originally inaccurate at the lightest as well as full load.

(4) Simplicity of construction; fewest parts.

(5) Ease of connection to circuit.

(6) Readiness for calibration and adjustment when required.

(7) Security against theft of current.

(8) Sturdiness, for transportation or handling.

(9) Protection against short-circuits.

(10) Appearance, style, finish. W. W. TITZELL.

For direct-current and alternating-current meters: Simplicity in design; compactness; low weight; accessibility to component parts for repairs; cost; "thief proof;" watts lost in potential circuit, and in series coil at higher loads; range; accuracy on fluctuation of load and voltage; maintained accuracy after short-circuits on load side of meter; torque; weight of moving element, and starting current.

For alternating-current meters: The above, and, additionally, accuracy on fluctuations of power factor; frequency, and change of wave form; simplicity of change to other frequencies.

A. H. A., N. Y. ED. CO.

Examination of construction with a view of determining its ability to withstand rough usage and its electrical construction with a view of determining whether or not magnets are permanent, adjustments readily made and resistances, *et cætera,* easily open-circuited. AUGUSTA RY. AND ELEC. CO.

(1) Accuracy on light loads for a long period of time.

(2) Ease of readjustment for recalibration.

(3) Simplicity of connections and permanence of sealing device.

(4) Freedom from liability to damage from lightning and short-circuits. (UNSIGNED.)

(1) The initial accuracy of the meter under all conditions of load.

(2) The permanence of calibration as affected by the torque and weight of the moving element, bearings, magnets, *et cætera.*

(3) The mechanical construction and general design as regards tampering, exclusion of dust, and repairs.

O. J. Bushnell.

One without commutator and brushes and that will operate on exceedingly light load, such as a hylo lamp. One that is easily gotten at for inspection and recalibration and is accurate on both inductive and non-inductive loads. C. W. Koiner.

(1) High torque combined with reasonably light moving element.

(2) Accuracy on light load.

(3) Independence of variation (within commercial limits) of voltage, frequency, wave form and power factor.

(4) Permanency of braking magnets.

(5) Compensation for increase of friction.

(6) Ease of adjustment and repair.

(7) Maintenance of initial accuracy.

(8) Low meter losses; particularly shunt losses.

(9) Closed magnetic circuits to obviate possibility of interference by external fields.

(10) Large dials and no dial constants. S. R. Inch.

U 17. What has been station experience for past few years with four types of bearings for integrating meters, as follows: (a) regular steel-ball pivot on round cup sapphire; (b) regular steel-ball pivot on flat diamond; (c) magnetic-flotation bearings; (d) ball and two-cup sapphires (present Westinghouse bearing).

Ball and two-cup sapphires. Fred B. Sharpe.

We find that style (a) gives very good satisfaction, but on our switchboard meters where there is some vibration we find that style (b) gives better results. The style (c) has given us the greatest trouble, as it takes more time and trouble to calibrate the meter when once out of adjustment. We have not used style (d). The Colorado Springs Elec. Co.

Magnetic flotation has proved satisfactory and entails least cost for maintenance. G. WILBUR HUBLEY.

U 18. What is the prevailing opinion among direct-current plants as to use of integrating watt-hour meters as against integrating ampere-hour meters, or equivalents of the latter?

Integrating wattmeters are conceded to be superior to all others. P. C. MORGENTHALER.

The integrating watt-hour meter has been considered preferable in direct-current distribution.
A. H. A., N. Y. ED. CO.

For general use, the wattmeter has the preference.
O. J. BUSHNELL.

Ampere-hour meters are entirely out of date and not to be considered. J. W. COWLES.

U 19. For alternating-current work, as a general proposition, have meters of the Thomson (commutator) type proved nearly equal to the better class of induction meters, taking all points into consideration?

No; the large weight of moving element resting upon a stationary jewel bearing is apt to greatly decrease the life of a jewel, due to the hammering effect upon the jewel surface, resulting from the alternating current. This is only one of the serious drawbacks, which are largely overcome in the modern small induction wattmeter. E. W. GOUGH.

For purely alternating-current work the better class of induction meters are preferable. P. C. MORGENTHALER.

Yes, nearly equal.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

I am inclined to believe that they have.
GEO. B. LAUDER.

No. W. H. GREENSLIT.

Yes. CLAYTON GEIGER.

Induction meters have proven more satisfactory for alternating service. G. WILBUR HUBLEY.

No. Their accuracy can not be relied on for as long a time and their shunt losses are considerably larger.
G. F. WILLARD.

Our experience shows that, all points considered—creeping, maintaining their calibration, *et cætera*—the Thomson commutator meters are better and more reliable than induction meters of the best type. We may have been unfortunate, but this is undoubtedly our opinion. W. H. THOMPSON, JR.

No. Commutator meters are much more expensive in maintenance; are more liable to error; need recalibrating at least three times as frequently, and are, unless specially lagged, incorrect on inductive loads. See reply to question U 15.
S. R. INCH.

No. A. H. A., N. Y. ED. CO.

No; far from it. AUGUSTA RY. AND ELEC. CO.

Induction meters have proved much superior for alternating-current work. O. J. BUSHNELL.

The Thomson recording wattmeter has been and still is a good meter and compares favorably with any meter on the market, provided it is given the same amount of care in the way of periodic inspection.

Meter design has improved, of course, and for new installations it is preferable to purchase a meter of later model. For a company with a large number of Thomson recording wattmeters in service to replace them with new meters would be questionable policy as the old ones will give years of service yet, if inspected and tested at least once a year. (UNSIGNED.)

No. R. V. West.

No; induction meters are far more satisfactory, both in accuracy and in cost of maintenance, than commutator meters and should be used exclusively in alternating-current work.
J. W. Cowles.

No. The losses are greater in the commutator type meter and they do not register as correctly on all loads as do the better class of induction meters. Thomas S. Richardson.

U 20. What is the cause of and practical remedy for the reversal of error range in a Thomson polyphase meter connected up for testing, both sides in series or connected on three-phase circuits; that is, why does the meter run fast on low loads and slow on heavy loads?

The error can be regulated with the light-load adjustment and the brake magnets. (Unsigned.)

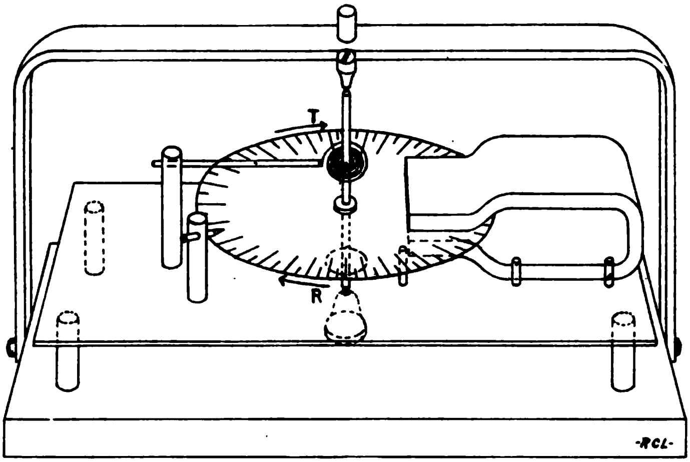
Mutual reaction of eddy currents in disc and series field.
J. W. Cowles.

U 21. What is a cheap and accurate way of determining the flux density of permanent magnets used for recording wattmeters?

If the absolute strengths are wanted, that is one thing; if it is the relative strengths between one magnet and another, that may be determined as follows:

Have a given load on the meter, which load may be kept constant. Put in a magnet and note the number of revolutions made in a certain given time by the meter disc. The exact position, as near as may be, of the magnet should be noted, and the magnet removed and another one put in in the same position; by again noting the number of revolutions of the disc during an equal time interval, the relative strength may be determined.
Geo. B. Lauder.

A very cheap and reasonably accurate way to determine the flux density of permanent magnets in terms of a deflection, although not quantitively in number of lines of force, is to use a copper or aluminum disc mounted on an ordinary spindle like the disc of an induction meter, and having fixed on the shaft one or more spiral springs of proper strength. At some point near the edge of the disc, and supported from the same frame that holds the bearings of the disc shaft, there is mounted a support, upon which a permanent magnet to be tested can be set so as to come against stops that will hold every magnet at the same place with respect to the disc. By turning the disc around by hand, one complete revolution, the spring is put under tension, and if the disc is released quickly it will swing around through the gap of the permanent magnet, and having the edge of the disc calibrated in degrees, it can be observed at what point the disc stops in its first swing with respect to a pointer fastened near the edge of it. The greater the swing the weaker the magnet, and in this way an empirical scale for the strength of the magnets to be tested, can easily be made. The device as described is shown in the accompanying diagram. R. C. LANPHIER.



The flux density of permanent magnets may be determined by inserting between the poles a little coil of copper wire connected with a ballistic instrument. This coil is suddenly removed and the throw of the ballistic instrument noted. For comparative purposes it is not necessary to standardize this apparatus. If, however, the absolute values are required, it would be necessary to standardize the apparatus by the use of a ballistic galvanometer of known constant. For practical use it would probably be sufficient to use a direct-reading voltmeter or millivoltmeter as the ballistic instrument. Another quick way of measuring flux density is by determining the change in resistance of a flat spiral of bismuth placed in the magnetic field. By arranging a suitable apparatus for measuring this resistance change, such measurements can be made with good rapidity.

ELECTRICAL TESTING LABORATORIES.

There is no particular object to be gained by determination of the absolute units of flux density of permanent magnets. Almost all of the manufacturing companies have established units of their own and the cheapest and best way in the end is to secure from them a machine that will do this work expeditiously and accurately. A. H. A., N. Y. ED. CO.

Magnets can be tested by substituting different ones on certain discs in meters operating under a given load.

AUGUSTA RY. AND ELEC. CO.

There is no cheap way of determining flux density of permanent magnets. The effective strength of magnets can be readily determined by using a regular Thomson recording wattmeter and comparing the magnets with one of known strength.

J. W. COWLES.

U 22. What damage does a meter sustain by being exposed to changes in weather, etc., attached to outside of residences in semi-protected places, such as porches, etc., with overhead protection?

Extreme changes of temperature and exposure to the elements will rapidly damage meter and cause it to become unreliable. G. WILBUR HUBLEY.

If the meter be sealed up tight and is practically waterproof it will sustain very little damage, provided the parts are so designed and finished that they will not corrode.

E. W. GOUGH.

Meters will collect dust and cause commutator and brushes to spark, clog up magnets; pivot will rust and wear jewels, which will cause meter to run slow.

THE COLORADO SPRINGS ELEC. CO.

None; sometimes a little rust will be found on iron or steel parts. CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Our experience has been that meters exposed to the weather, no matter how well protected, are soon injured, the injury being caused by sweating due to excessive temperature changes. All steel parts quickly become rusted, for which reason we never allow meters to be put outside of buildings.

CHAS. H. PETERS.

The heating and cooling of the coils, due to variation of temperature, also dampness, have a tendency to break down the insulation and also to open the potential path. The mechanism and sliding contact, if any, corrode more easily.

CLAYTON GEIGER.

A meter that is dustproof and waterproof, with enclosing case and cover of non-corrosive material, is practically free from damage with some overhead protection. W. W. TITZELL.

If meter is not air-tight some metal parts will rust, due to condensation of moisture therein. In any case, such a location is undesirable. W. H. C.

A properly constructed sealed type meter should sustain practically no damage due to changes in weather, *et cætera,* from being used outside of residences, if there is some little protection from the direct sweep of the wind and rain, as suggested. The writer knows of many instances where induction meters have been used in this way during the past four years and they are all running satisfactorily and give no more trouble than any other meters installed inside of houses in the usual way.

R. C. LANPHIER.

The Stanley meter suffers more from such exposure than do other makes. The piano wire that holds the disc in place tends to corrode, and this is apt to cause the meter to lag on small loads. (UNSIGNED.)

Parts may collect moisture, may corrode, or may be affected by contraction and expansion.

AUGUSTA RY. AND ELEC. CO.

The damage done under these conditions depends upon the type of meter used. If the meter has an air-tight case, the working parts will not be affected much; but if the case is not so tight, moisture may rust some of the parts.

THOMAS S. RICHARDSON.

Very poor practice, unless in a reasonably uniform climate.

J. W. COWLES.

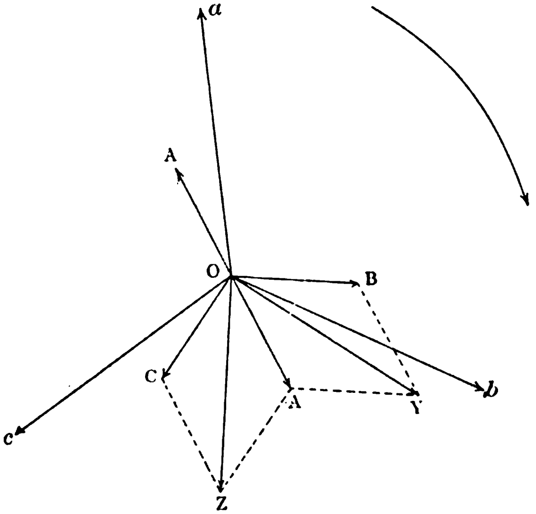
U 23. In metering a 3-phase circuit having a power factor less than unity by means of two single-phase meters, one meter runs slow; what determines which meter will be the slow one?

The slow meter will be the one with the lightest load on, which can be determined by connecting an indicating wattmeter in series with each meter and taking potential from the third wire.

THE COLORADO SPRINGS ELEC. CO.

The meter connected in the lagging phase runs slow. Before the meters are connected take voltmeter readings of the phases. The phase of low voltage will be the lagging phase, hence the meter on that phase will be the slow one. (UNSIGNED.)

Assuming that the load is approximately balanced, the meter whose current coils are in the wire next after, in phase rotation, the wire to which is connected the common potential tap will be the slow one.



For assuming a delta-connected load (see diagram) with the meter current coils in the wires *X* and *Y*, and the corresponding shunt coils across *ZX* and *YZ*, then calling the potentials *ab, bc, ca* and the corresponding currents *A, B, C.*

$$\begin{aligned}\text{Total watts} &= ca\,X + bc\,Y\\ &= ca\,(C-A) + bc\,(B-A).\end{aligned}$$

A vector diagram will best show the reason for one meter running slow:

Let *oa, ob,* and *oc* represent the voltages, and *OA, OB* and *OC* the corresponding currents lagging behind e.m.f's and 120 degrees apart. Since in our example the potential coils of the meters are across *oc* and *ob,* find the corresponding resultant currents in the line wires according to above formula. Subtract *OA* from *OB* and from *OC* by producing *OA* backwards, completing the parallelograms and draw the resultants *OY* and *OZ.* It will be seen that the current *OY* is more nearly in phase with the voltage *ob* than *OZ* is with *oc,* and therefore the meter whose series coils carry the *OZ* current will be the slow one.

Referring now to the diagram of the load, it will be seen that this is the meter in the *X* wire and that it is next in phase rotation after the wire with the common potential tap. A similar proof applies to the case of a star connected load.

S. R. INCH.

Depends wholly upon the relative current and potential connections of the meters with reference to motor.

J. W. COWLES.

U 24. Is it advisable to use a balanced 3-phase recording wattmeter for metering the power taken by the average 3-phase motor?

We think it is advisable wherever it can be used, as it is accurate and registers the true energy on one dial.

THE COLORADO SPRINGS ELEC. CO.

A meter of the polyphase type is better. GEO. B. LAUDER.

As the average three-phase motor does not operate under a balanced load, all the objections that exist against the use of one instead of two single-phase meters for measuring unbalanced loads exist against the use of a balanced three-phase recording wattmeter.

The same objections exist against the use of one single-phase meter on a rotary converter, which is generally called balanced, but which in actual practice is found to be very much unbalanced. W. W. TITZELL.

Yes. G. B. LELAND.

Yes. H. BOTTOMLEY.

No; we prefer the use of polyphase meters for this work.

A. H. A., N. Y. ED. CO.

Yes. This method is preferable to using two single-phase meters. (UNSIGNED.)

No. Meters should be used that will take care of the unbalancing changes sure to exist at times. J. W. Cowles.

U 25. What plan has been found to rectify delay in reading meters when located inside of buildings with occupants absent? This in view of the loss of time from a high-priced meter man's repeated calls.

Install prepayment meters. W. H. Greenslit.

Our minimum rate is $1.25 per month. Should meter reader not be able to gain access to premises after two or three calls, we charge that customer the minimum rate each month until meter can be read again, when we deduct as many minimum rates as have been charged since former reading from difference between last and former reading. Chas. H. Peters.

The best plan for rectifying delay in reading meters that are located in buildings when the occupants are absent, is to make some suitable arrangement with the customer whereby the local company is provided with a key to the room or building. These keys should be provided with numbered tags, so that if lost no outsider could use them to any advantage. The numbers should be kept by the company, and a strict record should be kept of the keys furnished the different meter readers. F. B. Owen.

Cut off the service until an agreement can be made between company and consumer to read the meter by some means without delaying meterman. Clayton Geiger.

Mail to the customer a return postal card upon which is printed a diagram of a meter dial, and request the customer to mark on this card the exact position of the meter hands and return to the company. F. Ellwood Smith.

Make an appointment by means of reply postal card.
J. W. Cowles.

If upon the second call of the meter reader to take index of the meter, he can not gain access to the same, it is customary

to leave a slip under the door, stating the date when he will again call. If in an apartment house, the janitor is advised that he desires to read the meter, and is requested to make some appointment. This generally results in our being advised when the index can be taken. Should this fail, however, the customer is either communicated with by telephone or by letter, either at his residence or business address, if the same can be ascertained.
W. R. B., N. Y. Ed. Co.

It is inexpedient to call more than twice. One man should be given a list of all meters not read on the first trip and several days after he can call again at these places. (Unsigned.)

Arrange in advance for the location of the meter—with the architect—in every case of a new building. In office buildings and apartments have a meter board installed in the basement. If customer objects to the expense of wiring, have them installed in a public hall or corridor. In case of a residence, in a pantry, for instance. Avoid private rooms which it may not be convenient to enter at almost any time. Douglass Burnett.

U 26. What is the average annual cost of maintenance (a) for meters of direct-current type; (b) for meters of alternating-current type?

Direct-current meters, $1.33 each; 0.40 each for alternating-current meters. The Colorado Springs Elec. Co.

U 27. What percentage of the investment in meters would be a reasonable figure for the expenses of the meter department in a plant with about one thousand meters?

Ten per cent. The Colorado Springs Elec. Co.

Should not exceed five per cent. G. Wilbur Hubley.

We have 900 meters of all kinds and the total expense incident to the running of the meter department is approximately 6.5 per cent of the investment in the same; about one-third of the meters are modern induction type, and rest being mostly commutator meters.

For the above expenditure all our meters are tested once a year and our kilowatt-hours generated to kilowatt-hours paid for averages 1.24. S. R. INCH.

U 28. Has there been a satisfactory arrangement with wiring contractors whereby the location of meter loops are accessible to meter readers, and are they found to live up to such arrangement?

The only satisfactory arrangement that can be made between the central station wiring contractor and the customer regarding the proper location of meter loops, is to have the location fixed by a conference of representatives of all three. The central station should adopt a set of rules, providing that the meters be located not more than six feet nor less than two feet from the floor, and should refuse to connect up installations where these rules have not been complied with, unless there be some good and sufficient reason why the meter can not be so located. In case the meter must be located in some less easily accessible place, the customer should provide the necessary means of reaching the meter without any great difficulty on the part of the meter reader. In larger stations, the superintendent of the meter department should in all cases confer with the contractor regarding the location of the loop. This plan was tried in a large central station where the writer had charge of meter work, and no trouble was experienced with the contractors. F. B. OWEN.

We refuse to install a meter unless the meter loop is located where accessible to our meter readers. UNITED ELEC. LT. CO.

If the company makes its own rules and gives them to the wiring contractors, with the understanding that the building will not be connected unless rules are complied with, we think the arrangements will prove satisfactory.

THE COLORADO SPRINGS ELEC. CO.

We have rules printed for wiring contractors to follow. One of these is that the meter shall be about seven feet from the floor. The rule is followed to a satisfactory extent.

DAVID W. BEAMAN.

We require such a rule, but make some exceptions at request of consumer only.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Company should issue to wiring contractors a small book of rules containing local interior wiring requirements additional to those of the National Electrical Code, such as maximum voltage drop allowed, location of service outlets, location of meter loops, *et cætera;* and should refuse to connect any installation in which these rules are not complied with.

WARREN PARTRIDGE.

Meter loops should be made as accessible as possible within reason, but we have not always been successful in getting contractors to so make them, although we have rules governing that matter. GEO. B. LAUDER.

There has been an agreement between wiring contractors to locate meter loops six feet from the floor. So far as living up to it, from my experience, you have to keep continual tab on them, and if meter loops are not in an accessible place, do not put meter in until done properly. CLAYTON GEIGER.

Unfortunately not. J. W. COWLES.

The following rule has been found most satisfactory in its application:

The position selected for the meter is subject to the approval of our inspector; this position must be free from vibration and dampness, and not more than eight feet above the floor. The branch cut-out leading to the meter loop should be provided by the contractor, who should also be careful to insure that the main conductors extending back to the service switch have capacity sufficient for the entire installation, in accordance with the usual standards. A. A. P., N. Y. ED. CO.

Every company should have a set of rules and regulations covering the locations of meters, the distance of meters from the point where wires leave the building, the position of outlet relative to the company's service on the street, and various other points of this kind. These rules should be distributed to the various wiring contractors, and it will be found that where contractors know what the company requires, they are entirely willing to comply with said requirements. F. G. PROUTT.

In some cities it is the practice of the company to refuse to connect a service where the meter can not be set at a distance of not less than two feet and not more than six feet from the floor. (UNSIGNED.)

U 29. Does a peep-hole in the meter cover induce the consumer to tamper with and try to stop the meter?

The peep-hole (glass in meter cover) does not induce the consumer to tamper with the meter; in fact, it has been our experience that the opposite result is obtained.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Invariably it does. The old style Thomson recording wattmeters being entirely closed, except the dial, showing no moving parts, caused little complaint and inquiry as to operation of meters, whereas a peep-hole in the meter is often broken, match sticks and hat pins are placed under the disc and the meter is often moved back in the middle of the month and a piece of glass placed over the hole after this is done. WILLIAM M. LEWIS.

Every man who has much experience with the public and electric meters comes to have the feeling sooner or later that a great many people make it their constant study how they can beat the company by tampering with the meter, and it is very likely that the sight of the disc revolving behind the glass in the case puts thoughts into their minds and sets them to work on the problem of stopping it, but with modern meters installed, a company is pretty safe if the meters are kept sealed securely. The only meters that I ever found that had been tampered with when they were properly sealed were some of the old Thomson record wattmeters, which had no glass in front of the disc. The cases of these were very light and ill-fitting and did not give much protection to the insides. In one instance I found a tiny hole in the case on a level with the disc, about the size of a No. 28 or No. 30 wire, and another time the party had blown some very fine iron filings into the meter which had been attracted by the magnets in sufficient quantities to effectually stop the disc. My experience leads me to believe that a person of that kind has a great respect for a seal, for he knows the consequences are serious if convicted of breaking one. When dealing with people of that kind a man must use extra precautions. One part of my territory, where there were sixty-odd meters, I used to visit every month for no purpose but to see that the seals were intact, the meters all right and the surrounding wires in proper condition. The sealing faces of the sealing pliers were smooth, but I stamped the company's initials on them and after I had got the meters properly sealed and had begun the frequent system of inspection I never had a meter tampered with.

East River Elec. Co.,
Per Meterman.

It is certainly not advisable to have a hole in the meter cover, as it places temptation in the way of the customer to tamper with the instrument. W. R. B., N. Y. Ed. Co.

No, we think not. Augusta Ry. and Elec. Co.

No. The more a customer can see of his meter the better. This is recognized now by the manufacturing companies, and most of the new models are furnished with glass covers exposing the registering mechanism and the moving element.

(Unsigned.)

No; the peep-hole is of very much value, as it enables the inspector to prove that his meter does not creep, and if the consumer desires to tamper with the meter he will do it, regardless of all you can do. Fred M. Lege, Jr.

No. J. W. Cowles.

U 30. Do repolished meter jewels and pivots give as good service as new ones?

If carefully cleaned out, repolished jewels will give excellent results. WARREN PARTRIDGE.

No. A new pivot should always be used with a new jewel.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Yes. AUGUSTA RY. AND ELEC. CO.

No, as you can not polish a jewel as evenly as it should be, and it is cheaper to put in new ones. FRED M. LEGE, JR.

For certain conditions practically as good results may be obtained, although a closer system of inspection may be required.
J. W. COWLES.

U 31. What are the advantages and disadvantages of an excessively high torque in an induction meter?

High torque gives accuracy on light loads.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

The advantage of a high torque in any meter, and particularly in induction meters, is the greater sustained accuracy, especially on light load for a long period, provided the construction of the meter otherwise is such that the high-torque feature is not offset by other disadvantages that make the meter worse for actual service than one with much lower torque, and in which the features of bearings, disc construction, *et cætera,* are better worked out. It is evident that a meter with a high torque will tend to run on a much smaller load than will a low-torque meter, other things being equal, and in case the jewel should become slightly roughened the high-torque meter will have a much higher accuracy on the light loads for a longer period than will the low-torque meter under same conditions; but if the high-torque meter is constructed with a heavy rotating element and a powerful unbalanced shunt magnetic field which produces extreme vibration of the rotating element continuously, the strong field and the heavy disc being necessary to get the high torque, then this meter will be manifestly inferior to one with a lighter disc, evenly balanced shunt field and lower torque, for the latter meter will not wear out its jewel bearing anything like as rapidly as the former, and it is really in the life of the bearings (which determine the accuracy of the meter on light load after continued service) that the superiority or inferiority of the high-torque meter as against a lower-torque meter is determined.

R. C. LANPHIER.

The advantage of the high torque is that friction is overcome and a small increase in friction (as from a rough jewel) does not cause so much lag as it would in a low-torque meter.

The disadvantage of the high-torque meter is its tendency to creep after recalibration unless great care is taken with the light-load adjustment; also the increase in the shunt loss, which becomes a considerable item when there are numbers of such meters in operation. (UNSIGNED.)

I find that the high-torque meter is a necessity, as it will register hylo lamps; many residences will use them all night and if your meter will not move you are the loser. They are, however, harder to keep from creeping. FRED M. LEGE, JR.

High-torque meter has power to overcome incipient friction.

JOHN J. GAFFNEY.

U 32. Where is the best place to locate a meter in a private residence, considering convenience for reading and inspecting and the least inconvenience to the customer?

From our experience, we find it best to locate meters on back piazza or in kitchen. Kitchen meters must be insect proof.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Where possible, in the rear hall upstairs; otherwise in kitchen. FRED H. BECK.

In the attic of the house. If no attic to which there is a stairway, then in a room not in regular use—depending on conditions. MADISON LT. AND RY. CO.

In an attic or in a room that is not private.
CLAYTON GEIGER.

In some lighted place in cellar, as most companies now operate or will operate both gas and electric properties, and a combination meterman reading the gas meter, which is invariably in the cellar, can read the electric meter in less time than if it were placed upstairs or in the attic. Dampness in most cellars is scarcely noticeable so far as the operation of the meter is concerned. WILLIAM M. LEWIS.

In the cellar. F. ELLWOOD SMITH.

With underground service, cellar stairway. With overhead service, cellar or attic stairway. Never in dark place or above seven feet from floor if avoidable. D. O'CONNELL.

The best location for a meter in a private residence is without doubt in the cellar. There it is accessible for reading and inspection purposes, and is less liable to cause inconvenience to the customer than at any other point that might be chosen.
E. A. N., N. Y. ED. CO.

In the cellar. This location has the additional value that the vibration here is a minimum. (UNSIGNED.)

The basement is the best place for the location of meters, provided a clean and dry place can be found in it. This will obviate the necessity of having meter readers, inspectors, *et cætera,* going through the house every month and will also, in most cases, make the meter accessible even though the house may be locked up. This is especially true in the case of apartment buildings.
GEO. H. JONES.

Locate your meters where your reader can see the dials without the use of search light or ladder, as it will enable him to read them much faster and if they give trouble you will hear about it sooner. FRED M. LEGE, JR.

Basement. J. W. COWLES.

A most convenient point from the company's standpoint is in the basement near the entrance of the underground service. For overhead supply, the kitchen or pantry.

DOUGLASS BURNETT.

U 33. In small towns using, say, 300 to 500 meters, is it advisable to employ an experienced meter man, at yearly intervals, to go over all meters in use?

In towns using as many as 500 meters, a man of experience in such lines should give all meters a thorough inspection and test once a year. LEE BOYER.

A town using from 300 to 500 meters should employ one experienced meterman, who should set and remove all meters, test all meters at plant before installing same, inspect and test each meter on the lines once in six months, make necessary tests on customers' complaints, and read the meter indexes each month.

WARREN PARTRIDGE.

Yes. CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

We find one can not be too careful about keeping meters up in good shape. P. H. KORST.

Yes. CLAYTON GEIGER.

It is certainly advisable for a small town having from 300 to 500 meters to employ an experienced meterman to test meters in service and those coming from the factory, and to keep an accurate record of all such tests. H. J. MEYER.

It is, as the increase in business due to cleaning and repairing meters covers the expense of the meterman in the first month and a half. From June 1 to September 15 is the best time for this work. WILLIAM M. LEWIS.

It will well repay such a station as is suggested in this question to have its meters carefully checked, as this is the only way of maintaining the confidence of the consumers in the accuracy

of the meters and of preventing large losses to the station on account of meters becoming slow. If all meters were enclosed in moisture-proof and dust-proof cases, this might not be necessary.
DUGALD C. JACKSON.

Yes. F. ELLWOOD SMITH.

Yes, we think so—or some equivalent method.
AUGUSTA RY. AND ELEC. CO.

It is advisable for any plant to have its meters tested at least annually.
O. J. BUSHNELL.

Decidedly yes. As the meters really decide what the income of the plant is, they should be kept in the best of repair. If only a small per cent of the meters are slow and the meter man discovers the trouble, it will more than pay his salary.
M. A. HOGAN.

Yes. Better results can be obtained and for less money than by employing year in and year out a low-priced and inexpert meter man. The high-priced meter expert may be the means of saving the central station much revenue and is paid for only the time he is with the company—a few months each year. That all meters in service should be tested at least once a year is admittedly the basis of good meter practice. It is best that it should be done by a man who is experienced in handling the problems presented by meter systems. (UNSIGNED.)

Yes, if you have not a man in your employ who is capable of testing your meters, for as a rule you will find them all slow. On the other hand, I would advise the purchase of an indicating wattmeter or a volt and ammeter, instructing some electrician in your employ so that he can check them at odd times.
FRED M. LEGE, JR.

Yes. J. W. COWLES.

U 34. Which is the better method of handling a meter department in a small company supplying from 500 to 1000 customers? Should one man be employed to devote all his time to reading and testing meters, extending the reading over several days, or should the readings be made by several men, taken away from other duties on two or three days of each month, the testing to be done by one man, who also has other duties? If the former method were followed, how many meters should one man be able to take care of properly?

Two competent inspectors should be employed, to devote all their time to reading, testing and repairing 500 to 1000 meters. Two competent men could easily take the readings of 1000 meters in three days.

A thousand consumers should keep two first-class inspectors busy twenty-three days out of thirty, making a systematic inspection of meters and repairs to meters, including cause and no cause for complaint by consumers.

CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

Should employ an experienced meter man; have him devote his time to meters only. One man for every 500 meters.

CLAYTON GEIGER.

One man can start reading meters on the twenty-sixth, have 1200 or 1400 meters finished by the thirtieth and bills entered in ledgers, *et cætera*, by bookkeeper, starting to deliver the bills on the first or mailing them on the night of the thirty-first. The same man could be used for collector and office assistant. Another man, one employed as foreman, can oversee all meter installations, test them, *et cætera*. This scheme has been in operation for three years and has been found most satisfactory.

WILLIAM M. LEWIS.

Let one man do all the meter work. Approximately 1000.

J. W. COWLES.

One man doing all the reading can go about quicker and he becomes more accurate. AUGUSTA RY. AND ELEC. CO.

It would be better to employ one man to devote all his time to reading and testing meters. He should be able to take proper care of from 800 to 1000. O. J. BUSHNELL.

It is desirable to have all meters read within as small a space of time as possible and preferably in one day. This can best be accomplished by using several men.

The testing and recalibrating had best be done by one man, who need be employed for only so long a time each year as is necessary for going over all meters in service. (UNSIGNED.)

We have 1100 meters installed in this city and make a practice of checking them every time they are moved, and where they are in use a year they are taken out, cleaned, checked and then put in use again. My switchboard man does the checking of meters and arc lamps; keeps them all in good repair and attends to the board, which is read every hour. He uses a bank of 100 lamps cut in sections of one to ten from 2-cp to 32-cp, and has a variable resistance for the different meters so as to obtain the necessary voltage; he also uses a small and large indicating wattmeter, as well as volt and ammeter in series with the meter to be checked, and by the use of a stop watch he can easily clean and check ten meters per day where the repairs are not very large. FRED M. LEGE, JR.

U 35. What method of metering current has been found best suited for installations consisting of single and 3-phase, 220-volt motors, resulting in an unbalanced 3-phase load?

Polyphase recording wattmeters.

RALPH D. LAXTON.

Any polyphase integrating wattmeter worthy of the name should care for an unbalanced three-phase circuit, and it is decidedly preferable over three single-phase meters, as it usually will be found cheaper in first cost, cheaper to install and takes up very much less room in the customer's premises.

M. CARRINGTON.

Use regular polyphase three-phase meter, which will take care of the unbalanced load. J. W. COWLES.

For the single-phase circuit (either one of the phases) any good single-phase meter may be used. The only completely satisfactory way of metering the three-phase circuit is to use a meter with two sets of running gear on one spindle, the respective coils of which connect to the three-phase circuit in the well-known manner of the "two wattmeter method."

DUGALD C. JACKSON.

U 36. We are operating a 500-volt, direct-current, 2-wire circuit for power, and while our lines, motors and meters are protected by lightning arresters, we lose from 10 to 15 meters in the spring from lightning discharges. What is the best method of preventing this?

Insert heavy reactive coils in both lines between arresters and meter. RALPH D. LAXTON.

Possibly grounds of the following nature would cover this: Bury a 24-inch by 30-inch copper-tinned plate in permanently moist earth, with charcoal or crushed coke to draw water. Connect without any sharp bends or angles (straight run of wires is important) large ground wire, say No. 0 B. & S., being careful not to cover the wire with a pipe, but, rather, put it in wood moulding. WILLIAM M. LEWIS.

If the questioner will keep a close record of the points at which he is losing meters and will plot them on a map, he will probably find his trouble is confined to a comparatively small locality where insufficient lightning protection is afforded. Given this information, he can then proceed to strengthen this protection. It is, of course, possible that the lightning arresters that he now has in service are defective or have insufficient ground connections, either of which troubles will render them practically useless. M. CARRINGTON.

See that your lightning arresters are clean and of the best make, that the connections are tight and that you have a first-class ground wire, free from turns, kinks, *et cætera*, and connected to permanently moist earth. W. R. COLLIER.

Grounding your meters may stop this trouble, but I am of the opinion that your lightning arresters are not watched very closely. FRED M. LEGE, JR.

Try a different type of lightning arrester.
AUGUSTA RY. AND ELEC. CO.

Put on better lightning arresters (that is, arresters with smaller air-gaps, which are more sensitive and protect against the rise of potential more effectively) or purchase meters with better insulation. DUGALD C. JACKSON.

The breaking down of 500-volt armatures is found to be a common result of static discharges, lightning or otherwise, for which no remedy has been found. J. W. COWLES.

V

ADVERTISING

V 1. What do you consider the best method of advertising the electric-lighting business?

The best method of advertising an electric-light business is by making a direct appeal in a sensible manner to the prospective consumer, on the yearly plan, never letting up on him, but keeping after him earnestly, on a plan drawn a year in advance. By making the plan in this manner, you insure its continuity, its interlocking force, and the logical sequence of the pieces. Go for the possible customer directly, and talk only one thing to him, but never approach the subject twice in the same manner so as to grow monotonous. Make the plan fit in with your salesmen by constantly soliciting an interview, while you are putting forth your best arguments. This will disclose the people who are the easiest of approach. If you make it easy in replying to name a day and hour for an interview, you will conserve your salesman's time.

CONVERSE D. MARSH.

I consider the best method of advertising the electric lighting business to be a judicious campaign through the mails, addressed to a selected mailing list, vigorously followed up by personal solicitation. La Rue Vredenburgh.

Electric signs, and up-to-date methods in conduct of business. G. Wilbur Hubley.

By furnishing better light than anybody else can furnish and at reasonable rates. United Elec. Lt. Co.

No single method of promoting publicity can be called adequate to the requirements when advertising. In a business such a electric lighting, electric power and electric heating, it becomes largely a matter of the education of the public; and the public can not be reached through a single channel.

First and foremost, we would say that for any sized town or station newspaper advertising is good—generally necessary—but too expensive a method to depend on for detail and detail is quite a necessary accompaniment to education. Supplement this general advertising with either circular letters, printed circulars, or both, with an occasional booklet on a more elaborate scale. If the field is large enough and warrants it, the monthly bulletin is advisable, but almost too expensive except for cities of the first class.

Newspaper advertising will pay anywhere if properly done. The smaller the town, the lower the rate should be, and to just what extent one should indulge is very difficult to say. The business should be put prominently before the reading public in a newsy and attractive style, and so often that they will never have a chance to forget you.

This gives the general publicity

Then prepare a selected mailing list compiled from the directory, a general knowledge of the town, and from the reports of the solicitors, and keep in touch with these people through personally-addressed letters, and such printed matter as will apply to their different requirements. For instance, get some data on elevators, a cut or two, and make up a circular putting forth your claims to the superiority of the electric and central-station service. Mail one to every possible user of an elevator on your list, and if a seeming personal letter or recommendation from a prominent consumer can accompany it, so much the better. Prepare another on forge blowers, or on the various applications to wood-working machinery, on store lighting, on residence lighting. Just how often, will vary with the conditions. But keep the one point in mind—that you are to show the people you are always alive and pushing for their business. Then they will give you a chance. R. Louis Lloyd.

Any legitimate method that would benefit customers and increase business; for instance, newspaper advertisements having glowing head lines as to the cheapness of electric power for the operation of John Smith's or Bill Jones's place of business for the past three months. C. C. Gartland.

Good continued service, and descriptive matter sent out with bills each month. C. W. Koiner.

Monthly bulletins, each on a specific subject, and giving as full information as possible, not neglecting prices of apparatus and service; and showing photographs of actual installations in your own district, accompanied by letters from the customers. Send these monthly bulletins to a mailing list containing architects, builders, and prospective customers reported by solicitors. Keep a business directory, and send bulletins to all people who may be interested in the particular question discussed.

Have a liberal policy in your relations with your customers by avoiding charges for extras, and minimum charges where possible.

Give your attention not only to the management and operation of your company, but study to find out how your service may be used by different classes of people, and why it should be used in preference to other methods, if at all.

Douglass Burnett.

This depends largely upon conditions. In large cities, a combination of several methods has been found expedient. In towns of from 5000 to 25,000 population, newspapers can be used to advantage. Folders covering some special feature of electric lighting can be sent out occasionally with good results, and at small expense. D. H. Howard.

V 2. Is a monthly bulletin or paper valuable to small stations for advertising purposes?

We believe not; it is better to use any surplus in perfecting your system, and giving the best possible service at a reasonable rate. Furnishing customers the real thing satisfies them better than a little picture book or a fairy tale each month.

CHAS. H. PETERS.

A monthly bulletin or paper is valuable to small stations, if it is arranged on a syndicate basis; that is, a number of cities joining in the effort. Small stations by this method will have their bulletin make a creditable showing. CONVERSE D. MARSH.

I do not consider a monthly bulletin of much value in cities of less than 100,000 inhabitants. LA RUE VREDENBURGH.

See answer to question V 1. R. LOUIS LLOYD.

Extremely so. DOUGLASS BURNETT.

The monthly bulletin can be used to good advantage by small stations, although in the large majority of cases the station would not be warranted in publishing it. These can be obtained from some advertising agency on the syndicate plan, monthly, in quantities desired. D. H. HOWARD.

V 3. Does newspaper advertising pay in towns of less than 5000 people?

In our opinion, it does not. CHAS. H. PETERS.

Newspaper advertising in small towns will not pay unless it is very cleverly and craftily done. CONVERSE D. MARSH.

I consider the main value of advertising in newspapers in towns of less than 5000 inhabitants to consist in keeping the newspapers themselves in line, except in towns where lighting companies are just starting business or into which they are extending their lines for the first time.

LA RUE VREDENBURGH.

Yes, more especially because it keeps the good will of the papers. F. ELLWOOD SMITH.

No; but keep yourself before the people by doing something out of the usual run of things. L. E. WATSON.

I do not think so. ANDREW F. HALL.

See answer to question V 1. R. LOUIS LLOYD.

Newspaper advertising can be made to pay in towns of less than 5000 population. Every one reads the local paper, advertising rates are low, and if the proper copy be properly prepared and presented, it should show results. D. H. HOWARD.

V 4. In a city of 25,000, to what extent is it profitable to advertise by means of prepared printed matter mailed to prospective customers?

Printed matter and letters mailed direct to the prospective customer, are good in a city of any size. The common-sense rule of going to a man and asking for his business should prevail, and you can ask him more persuasively, tactfully and "remorsefully" of you do it by mail, utilizing the salesmen to work up the "soft spots" that your replies develop. I do not understand why you state in this question, a city of 25,000 inhabitants. CONVERSE D. MARSH.

In cities of 25,000 inhabitants I should say that the expenditure of one per cent of the gross receipts per year in advertising should prove profitable. LA RUE VREDENBURGH.

See answer to question V 1. R. LOUIS LLOYD.

A booklet, such as gotten out by several publishing houses, if properly followed up, ought to do good work.
AUGUSTA RY. AND ELEC. CO.

It is very doubtful to me whether or not it is ever profitable to mail printed advertising matter indiscriminately to prospective customers. Most of it goes into the waste basket, anyhow. In so small a town as the one mentioned, the superintendent should know pretty nearly what specialties it would be possible to interest a prospective customer in. If a card index is kept, indicating such lines, it will be found of great assistance. Whatever printed matter is used should be sent direct with the solicitor to the man you desire to reach. Otherwise, you scatter your ammunition and waste most of it. H. T. HARTMAN.

An attractive folder, say once a month, dwelling upon some special electrical feature appealing to residences one month, the next month to business houses, augmented by a weekly display advertisement in the local paper, can not fail to be productive of results. D. H. HOWARD.

Put an interesting little slip into every envelope mailed from your office. DOUGLASS BURNETT.

V 5. Of the various forms of advertising adopted by manufacturers, which appeals to you most strongly or best accomplishes its purpose? This with special reference to large and small advertisements in technical papers and indiscriminate and persistent circularizing.

I do not believe in indiscriminate circularizing. You ought to circularize on carefully prepared lists.
CONVERSE D. MARSH.

I consider well-placed and properly-worded advertisements in technical papers of more value than indiscriminate circularizing, but not so good as judicious and persistent circularizing.
LA RUE VREDENBURGH.

Large advertisements in techincal papers.
G. WILBUR HUBLEY.

Large and small advertisements in technical papers appeal most. AUGUSTA RY. AND ELEC. CO.

For manufacturers, the bulletin and catalogue are most effective. An occasional novelty can not go amiss. Technical papers are valuable where competition is brisk.

D. H. Howard.

Pick out the man you want to convert, find out what you can do for him, and how your proposition should most appeal to him, then send to him and circularize him until he adopts your proposition.

Douglass Burnett.

V 6. (a) Do exhibit and display departments pay? (b) Could not a widely-announced exhibition of electrical novelties be arranged yearly, or oftener, to advantage?

Exhibit and display departments are all right—are very educational; but you have got to advertise among the people in order to get them to visit such display. This display feature has been carried out splendidly in Boston, and at a trifling cost, because all the manufacturers were glad to donate the apparatus.

Converse D. Marsh.

In small towns, I am of the opinion that a yearly exhibition of electrical apparatus, properly announced and advertised, should prove profitable to the lighting company, and in larger cities, say of 300,000 inhabitants or more, a permanent electrical exhibition is of undoubted value.

La Rue Vredenburgh.

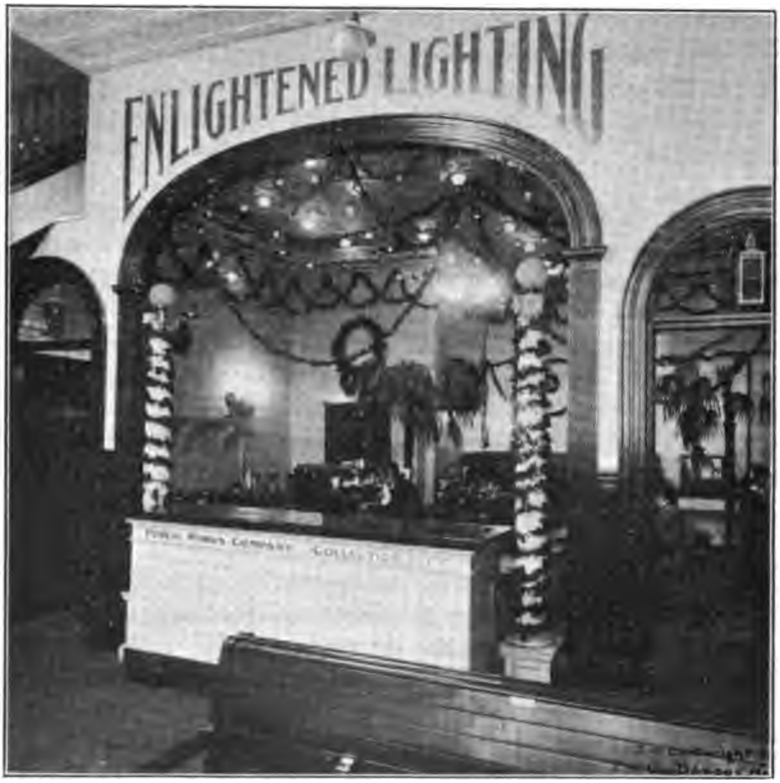
Think such a plan most excellent from view-point of advertising. Practical demonstrations and education of the public on electrical subjects and methods would prove of great benefit.

G. Wilbur Hubley.

An exhibit and display department for a small plant is an excellent means of advertising, and brings good results.

A. R. MacKinnon.

An exhibit and display room is a very advantageous feature to assist the solicitors. Attractive display, comfortable seats and a polite solicitor help greatly in gaining business. A small company can combine a collection and display department.



We are also street-railway operators. This small exhibit-room is about twenty-five feet square and occupies the rear of our street-railway waiting-room. The illustration shows Christmas decorations in place, to show Christmas-tree lighting outfits. The two columns inside the arch are removable and fitted with cord and plugs, so that they can be taken into any house or building for decorative purposes. The phrase "Enlightened Lighting" we run in all advertising matter, keeping it up until when one mentions or hears the phrase he knows its electric lighting. Some little circulars illustrate that point. I do all advertising myself. JAMES W. CARTWRIGHT.

If well preceded and backed up by good work, this ought to be a good scheme.
Augusta Ry. and Elec. Co.

Every live central station should have some system of displaying standard and new appliances. Ofttimes a customer is made by becoming interested in some little convenience such as a curling-iron heater or an inexpensive portable lamp. Small stations could adopt the plan of a yearly display to advantage where a permanent display would not be practicable. Manufacturers would gladly loan articles for the purpose. Space could be arranged for in some conveniently located store-room in the centre of the business district; a show-window for instance, could be utilized, and the display advertised in the local paper.
D. H. Howard.

Better have one customers' or reception-room set apart where all customers will come for the payment of bills, making inquiries, signing contracts, or what not, and keep a timely display of the applications of electric current.
Douglass Burnett.

The company that the writer represents is convinced that display departments are decidedly advantageous. It has been found that most of the apparatus will be cheerfully furnished on consignment by the manufacturing companies, and the existence of it affords an opportunity to bring the customer to the office of the company and interest him.
John F. Gilchrist.

W

CONTRACTS AND RATES

W 1. What is the remedy for customers using too much light on flat rate, the town being too small for meter service?

If the town is too small for meters, quit the business.
Elbert D. Kelley.

The writer thinks that there is no practical remedy, except a meter.
F. S. C., Malden Elec. Co.

There are on the market one or two devices that can be set to allow a certain amount of current to pass through them without interruption, but which cause the lights to flicker if the established amount is exceeded. While we have never tried them, it would seem that they could be of much service under the circumstances named. GEO. B. LAUDER.

I do not think any town is too small for meter service. I believe the flat-rate system is thoroughly bad.

A. J. CAMPBELL.

If there is a remedy, we never heard of one, except the meter itself. Various methods of charging have been tried, but with little success, and appliances to prevent people from burning more lights than they pay for have been used from time to time, but the small difference between the cost of these and cost of meters leaves everything in favor of the meter. If a town is large enough to justify an electric light plant, it surely should be large enough to justify a meter system—for the reason that if all lights are on a meter basis, you can furnish current to consumers having 1000 connected lights with about 25 per cent less machine capacity than you could where flat rate rules. By this, I do not mean 1000 business or store lights, but simply the general average of store and residence lighting in any town. CHAS. H. PETERS.

Install meters. Meters should be used even in the smallest plants. F. ELLWOOD SMITH.

No town is too small for meters. L. E. WATSON.

Install recording wattmeters on such customers' lines, and make a charge for all current used over and above a certain amount. A. R. MACKINNON.

Inherent weakness of flat-rate system which can not be regulated. G. WILBUR HUBLEY.

All lighting should be done by meter.

ANDREW F. HALL.

It does not seem as if any town could be too small for a meter service. If such is the case, the cheapest way to better the conditions would be to charge the flat-rate customers for their lamp renewals. K. L. W.

No town is too small for the meter system nor is any installation too small to be metered. E. A. BECHSTEIN.

If a party uses too much current on a flat rate, there is only one way to do. Either insist upon a meter basis or that he reduce the consumption. It is always better to insist upon a meter being installed as a guide, and in this manner it can be determined whether or not the light is in excess of the contract conditions. Where it is, either adjust on a basis of a larger amount or insist that meter service be used entirely.
C. A. L., N. Y. ED. CO.

Careful checking up.
AUGUSTA RY. AND ELEC. CO.

Put in meters; there is no town too small for this service.
R. V. WEST.

No town is too small for a meter service. It is just as unreasonable to sell current by flat rate where the consumption of current is left entirely to the discretion of the customer as it would be for a man to purchase his yearly supply of dry goods at a flat rate, regardless of how much he might expect to use. F. G. PROUTT.

Increase your flat rate, or install meters.
DOUGLASS BURNETT.

Install the Lacey automatic controller.
C. M. WRIGHT.

W 2. What is the best and most practical way of changing from flat to meter rates; also the most favorable time for making such change?

Maintain a high flat rate, and in the spring or early summer when nights are getting short, install a meter and show the customer what he consumes each month; then fix a price for deposit for use of each meter, to be refunded when meter is surrendered. This will make a permanently satisfactory customer.

ELBERT D. KELLEY.

The most favorable time for making change is in the spring.

F. C. S., MALDEN ELEC. CO.

The first thing to do is to determine in your mind what your meter rates are to be. It is important that rates fair to company and consumer be established and then adhered to, as a vacillating policy is undesirable. When ready to do so, notify all your customers that the change will be made and state good reasons for making it. We made the change about eight years ago and selected the month of May in which to make it. If the question means to ask what are the mechanical details of making the change in each place where the service enters it would require some study of the local conditions to answer.

GEO. B. LAUDER.

One way, and about the only way known to the writer, to change from a flat rate to a meter basis, is to simply make the change and carry it out with every customer. Make the announcement in a quiet way that hereafter everything will be on a meter basis. April is a good time of year to make the change. During the first few months it may be necessary to use a little tact and diplomacy and to give some good-sized rebates from bills, explaining to the customers in the individual cases that you do it because of their lack of experience in using light on a meter basis and you do not wish them to suffer a loss while adjusting themselves to the changed conditions. You may lose a few customers. All friction and trouble should pass off inside of three of four months. A. J. CAMPBELL.

In changing from flat to meter rate it should be explained to the customer that it is to his advantage to be on a meter basis, as he can then install the lights where he does not expect to use them enough to afford to pay the regular flat rate, as it will cost him for only the current consumed. Also explain that on such a basis very one pays for what he gets and is not called on to help pay for the service other people, who are abusing the service by allowing the light to burn when they are not needed, are getting.

Or if it is a party who has been taking unfair advantage of the flat rate, simply put him on a meter and tell him it is a case of taking it on a meter or not having it at all. We have always aimed to make changes in the summer time, so that the bills will be lighter for a while than when they were on a flat rate, as customers will then see that on a meter basis the cost will perhaps average the same; while if the change is made in the winter one will have lots of trouble in convincing the customer that his light is not going to cost far more than it has been costing before. F. L. WILLIAMSON & CO.

Notify the customer at the expiration of his contract that it will not be renewed on a flat-rate basis, and preferably in the spring of the year, when the bills are getting lighter all the time. G. B. LELAND.

The best and most practical way of changing from flat to meter basis is, in my judgment, a form of ballot. Send to every customer a printed letter to the effect that it is the desire of the company to make either the meter or flat-rate system standard throughout, but before doing so, it wishes to consult all its patrons and therefore asks them to express their wish by scratching out one or the other system named, the one not scratched being the one approved. A 10 or 20 per cent majority in favor of one system will be considered conclusive. Of course a brief outline of the advantages of meter system should be given, and a sliding scale promised, which would make a cheap rate per kilowatt-hour to heavy consumers. The most favorable time to make such a change is in the spring, when bills begin to decrease. As a potent factor in domestic economy, the meter is not sufficiently appreciated by the average household. In a clear, earnest, and persistent way, it teaches the folly of extravagance, and seldom fails to impress upon those who become acquainted with it, that "Economy is the road to wealth."

CHAS. H. PETERS.

Install meters in April or May. F. ELLWOOD SMITH.

Make the change in the spring and tell your customers to be careful or their bill will be larger; the result will be that very often their bill is smaller and they will tell their neighbor.

L. E. WATSON.

Install your meters and guarantee the customer that the meter bill for, say, three months will not exceed his old flat-rate bill. This will enable him to learn how to use a meter and should preferably be done during the summer months

A. R. MACKINNON.

Change, if possible, in May or June.

ANDREW F. HALL.

Change over during the summer months. A. PETERS.

Do it! Select March or April for the change. Gross earnings may suffer for a month or two, but the chances are that they will recover quickly. If it is possible to advertise a reduced rate at the time of change, new business will come in in excess of the shrinkage from the old. Here is an example of what it will do for you in changing from flat rate to meter.

The example is a hotel in Bangor, Maine:

Kw-hour Consumption Flat Rate Year 1902		Kw-hour Consumption Meter Year 1903
8755	February	4507
9272	March	4987
9492	April	4387
7246	May	3732
8338	June	4104
9082	July	3313

The monthly charges in 1902 and 1903 footed up about the same total. J. W. CARTWRIGHT, JR.

The only practical way known to the writer to change from flat to meter rates is to change. The experience of the larger companies has taught that the best time for change has been in the spring when the consumption is naturally going down. This is done in order to prevent, as much as possible, complaints from the old flat-rate customers, who have been burning light regardless. It would also give your customer time, during the summer months to begin to economize for the fall and winter, so that he will not have such wide discrepancies between the old flat-rate price and his winter meter rate. K. L. W.

Where it is desired to change a number of customers over from a flat to a meter basis, it is well, if the number of changes is more than can be handled within a few days, to have a regular series of notices sent to the customers, and the written notices followed by a call from a company representative. We have found it better always to give notice in advance of a desire to make such a change and then to have the written notice followed promptly by a call. It would seem better to make the change at a time of the year when the bills of the customer are lightest, but if the company has at its disposal a series of meter readings that can be used as a basis, it is well to have these on hand and then to go over with the customer the difference in price between the flat rate and what it would be under a meter basis.

C. A. L., N. Y. Ed. Co.

Spring or summer. Augusta Ry. and Elec. Co.

Convince your customers that they do not require the light that they are wasting; adopt a meter basis that will encourage long-hour service, and make the change in the spring.

Douglass Burnett.

Get after your consumers in the short lighting season; take May or June. R. V. West.

Send a solicitor to see each consumer in person. This man should be well posted on central-station operation and costs, and can easily convince the consumer of the necessity of such a change. In the spring is the most favorable time, as consumer readily appreciates that he will gain during the summer months in the change. If change is made during winter months, he has high bills staring him in the face at the outset. GEO. N. TIDD.

W 3. Has the legality of the ordinary lighting contract been tested, and with what results?

A company should not, except in very rare instances, attempt to enforce its contracts by process of law. The contract should be a simple and distinct understanding between the parties thereto, and it should be flexible enough so that should unforeseen circumstances arise, beyond the control of either of the parties, there might be some method of arriving at a proper agreement without going to law. F. G. PROUTT.

The ordinary lighting contract is a very variable proposition. It is better to have a simple form of contract with a few sentences than to go into details, many of which it will be impossible or undesirable to adhere to. DOUGLASS BURNETT.

Under ordinary conditions the lighting contract is not of very great value beyond its moral effect. Clauses as to waiving liability in case of high potential coming into houses have been overruled, and attorneys, as a rule, decline to try out guaranteed bills when service is not rendered. GEO. N. TIDD.

W 4. Can any information be given relative to a system of charging without contract? Is it possible to hold customers without requiring a contract to be executed for a period of at least one year?

Since the ordinary lighting contract has only a moral effect, it seems that the customer will stay on your books provided you give good service and make reasonable charges.
J. W. CARTWRIGHT, JR.

Make the usual term one year, and have it understood that in the event of removal, or for such other reason as may positively prevent the customer from using the service, the contract may be canceled at his wish. Make temporary contracts for building construction, for convention displays, and for summer fan or lighting business. DOUGLASS BURNETT.

It is questionable whether or not it is desirable, even if possible, to undertake to hold a customer who discontinues the use of current before his year is up, even where there is a contract, as the courts would require the company to prove damages. It could do this only by bringing its books into court, and the resulting newspaper outcry over the apparent profits shown would do much more harm than the comparatively small amount of damages obtained. H. T. HARTMAN.

It is difficult to understand how persons can charge for service except a contract be made. It is always well to insist upon a contract being executed, and that the charge be made in accordance with the terms of the contract. Special contracts are always troublesome, for they will involve one customer with another; but should a party desire to use service without a contract it can easily be explained that there will be no basis of charge, and questioning may therefore arise as to the proper method of charging. We therefore always insist upon a contract, and unless good cause can be given otherwise, we ask that a contract be made for the period of one year.

C. A. L., N. Y. ED. Co.

W 5. Are not public service corporations supplying electricity equally liable with railroads, etc., to charges of discrimination if their scale of rates or the discounts allowed depend upon the quantity of current delivered? If the size of the installation to be served is taken into consideration in connection with the sliding scale mentioned in the above question, can the sliding scale be justified?

A sliding scale of discounts for very large consumption can be justified by decreased cost of distribution. Discounts for increased average daily use per lamp are certainly justified by the greater economy of operation of your station under such a load;

by the fact that the customer increasing his average use gets his increase at a time outside of peak hours; and by the fact that your fixed charges are distributed over all of the hours of use.

DOUGLASS BURNETT.

The railroad rates are regulated by the Interstate Commerce Commission, a body appointed under United States laws. They are also regulated to some extent by similar State commissions.

An electric light company is more strictly under municipal regulation, although equally liable under State or national laws. At present we know of no law that forbids discrimination in rates depending on the quantity of current delivered, but there is no doubt that we are liable to have legislation that will cover this very point.

H. T. HARTMAN.

An electric light company offering a system of rates that makes each customer's bill bear the same fixed proportion to the cost of supplying him, will be in the best position to meet charges of discrimination.

A company can approach such a system much more closely with a sliding scale based on the ratio of consumption to size of installation than it can by a flat rate per kilowatt-hour with discounts for quantity. It is better, however, to base the sliding scale on the ratio of consumption to maximum demand rather than to size of installation, as it is the maximum demand and not the size of installation that determines the station investment.

It is also difficult to ascertain the size of installation, that is, the connected load, without intruding on a customer's premises in the first place and spying on him afterward. The maximum demand can easily be measured by an indicator.

J. S. CODMAN.

W 6. Is it a good plan to have the fixed charge per kilowatt-hour for all meter customers and then give discounts for payments at the office before a certain date, the discount to vary with the amount of customers' consumption?

We find it simplifies accounting and brings customers into the office, where they get acquainted with the management and can see any new lamps or appliances that are out; it also does away with collectors' services.

THE HOME ELEC. LT. AND STEAM HTG. CO.

Yes. FRED B. SHARPE.

A discount for payment of accounts at the office by the fifth of each month is a good plan.

Bills should not be discounted according to amount of current consumed except that the connected load be considered. A customer with five lights burning four hours per day should pay the same rate per kw-hour as a customer with 25 lights burning four hours per day. Discount according to hours' service per day per unit of connected load. ELBERT D. KELLEY.

Yes. F. C. S., MALDEN ELEC. CO.

It is advisable to give a discount for prompt payment.

GEO. B. LAUDER.

Yes. ANDREW F. HALL.

Personally, I think that a cash discount for prompt payments is a desirable thing. F. ELLWOOD SMITH.

Yes. By making a standard base rate you put every consumer on the same footing, and eliminate much trouble for yourself. Then make no secret of the fact that the large consumer gets the advantage of larger discounts, and tell all that they are entitled to the same when their consumption reaches the proper point.

The time limit works advantageously because it makes it easier to get the money, and if you have to wait and run after it, the penalty is lawful. R. LOUIS LLOYD.

Discounts for payment before a certain date cause much dissatisfaction when tender of payment is made a day or two after expiration of the discount period. Better see that your customers have good credit or make a deposit, and then do away with the cash discount. The so-called cash discounts of five or 10 per cent offered by electric companies are not warranted in ordinary mercantile practice. DOUGLASS BURNETT.

We fear the discounts would be too large and would make trouble. AUGUSTA RY. AND ELEC. CO.

It is well to make out bills at a fixed charge to all customers and give a discount at the office if paid before a certain date in the month. C. W. KOINER.

No; for the reason that the rates will overlap, and one customer may have to pay more money for less consumption than another. Further, with this kind of rate necessitating large discounts to the large customers, it is practically impossible to penalize non-payment by any certain date by withholding the discount. A better way is to make a sliding rate with a certain discount, say 10 per cent, for prompt payment. We have changed our rate from one having a straight rate with sliding discounts to one having a sliding rate with a 10 per cent discount, payment in ten days, and have found same much simpler and more satisfactory generally. The sliding scale satisfies the customer and the cash discount has a wonderful effect on the collections.
S. R. INCH.

No. Vary the charge per kilowatt-hour according to the amount used, and give a fixed discount—say 10 per cent for cash —payable before a certain date. With a fixed kilowatt-hour charge and large discounts to large consumers, it is difficult to enforce payments before date of discount limit, and an attempt to collect at list price after this date is likely to cause trouble.
R. V. WEST.

W 7. At what price must electricity be furnished per kilowatt-hour to compete with natural gas at 27 cents per 1000, for power purpose?

(Answers to this question will be read in executive session.)

W 8. With gas at $1.25 for heating and $1.50 for lighting, what are the best rates that can be obtained for electric lighting? Both gas and electric companies under the same management.

With gas rate of $1.50 per 1000 feet, electric light should compete at rate of 15 cents per kilowatt-hour.

G. WILBUR HUBLEY.

Start with current at 20 cents per kilowatt-hour, if a new company. If an old company, your rates will depend upon precedent and the propriety of your schedules will be subjected to a great diversity of opinion. DOUGLASS BURNETT.

From nine to twelve cents. C. W. KOINER.

This greatly depends on the community in which you are transacting your business, as there are some classes of people who consider dollars and cents only, regardless of the quality of light. I should say, however, an average of from 10 to 11 cents per kilowatt-hour for lighting. C. M. WRIGHT.

W 9. For a town of 20,000 inhabitants, which is the most satisfactory way of selling current; at an average rate of ten cents per kilowatt-hour or on a sliding scale, 7 to 15 cents, according to consumption?

This question can be answered readily enough by saying that neither rate will work out correctly; but it is another proposition to lay down a rate that will, as there are almost as many different ideas on this subject as there are station managers. We propose to establish a sliding-scale rate, 20 cents to 4 cents, and in addition to the meter rates we shall charge a base rate of 10 cents per 16 candle-power, or equivalent, for all lights connected, this 10-cent rate to cover fixed charges for service connection. The meter rate will be subject to a 25 per cent discount if bills are paid on or before the tenth of the month. A customer's rate will be established, not according to the kilowatt-hours burned, only, but the kilowatt-hours burned taken in connection with the number of hours his entire load is connected will establish this rate.

F. N. AVERILL.

By all means sell current on a sliding scale in a town of the size named. CHAS. H. PETERS.

From a commercial point of view I believe in a sliding scale and prices to fit the conditions under which the current is used, as some business is particularly desirable and should be sought by advantageous rates. GEO. B. LAUDER.

Sliding scale. It is better to have a standard established rate than to try to make special contracts. Special contracts are very apt to cause trouble sooner or later. F. ELLWOOD SMITH.

Fifteen cents and discount of five to 50 per cent.
ANDREW F. HALL.

Have found that some one of the capacity systems of charging results in the most satisfactory relations with the customers. We charge 16 cents for the first hour's use per lamp installed and six cents for all subsequent current used.
J. W. CARTWRIGHT, JR.

We find the sliding scale most convenient and satisfactory.
AUGUSTA RY. AND ELEC. CO.

Seven to 15 cents per kilowatt-hour. R. V. WEST.

For long-hour consumers give a sliding-scale basis on hours' use of capacity installed or hours' use of demand load. It is not satisfactory to give a standard rate of 10 cents, as it will be high for long-hour consumers and too low for short-hour. The Wright demand with various modifications would probably solve the problem. GEO. N. TIDD.

W 10. Is it better to tend as much as possible toward open rates applicable to all who come within specified classes as regards consumption of current, etc., or to make special rates and contracts with individuals, based on individual requirements?

The first is much preferab'e. The writer thinks special rates and contracts, when based on individual requirements, cause a great deal of controversy. F. C. S., MALDEN ELEC. CO.

It seems better to make open rates and adhere to them, as a general proposition; there are, however, individual cases which should be treated as such, and if the requirements are such that the service is especially desirable it should receive special consideration. GEO. B. LAUDER.

We think it better to use an open and published rate to all consumers wherever possible, as the assurance to a consumer, or possible consumer, that his rates will be exactly the same as all others in his class satisfies him that his competitor in business is not gaining any undue advantage over him, and goes a long way to prevent his constantly trying to obtain a lower rate.

J. S. WHITAKER.

It is better to use open rates applicable to all, so that no charges of discrimination can be rightfully brought against the company. A. R. MACKINNON.

Special rates to individual parties, based on special conditions of their requirements, are the most equitable.

G. WILBUR HUBLEY.

One rate to all pleases the customer best.

J. W. CARTWRIGHT, JR.

This question is somewhat involved, in the same way as in question W 4. It is preferable to have a uniform basis of charge, and to bill everybody on this basis, rather than to have special contracts for individual cases. Where special contracts are made, the company becomes involved, one customer with another, and then comes the difficulty of explaining why a rate given to one was not made to the other. Have the several rates divided, as between retail and wholesale, but where the rate is decided on make it universal for all customers coming within that class.

C. A. L., N. Y. ED. CO.

Our rates are open, and are the same to all.

AUGUSTA RY. AND ELEC. CO.

It is better to subdivide the business into various classes and treat all who come under any of the classes in exactly the same

way, because any special rate made to an individual will soon be known by other customers, with very unsatisfactory results to the company.
F. G. PROUTT.

Speaking for the company that I represent, we believe in rates that shall be open to all comers, simplifying the classes as far as possible.
JOHN F. GILCHRIST.

Make various schedules to take into account load factor and average daily use of the load, as well as time of the use of the load, and the cost of equipment and renewals; take into account all possible conditions. Avoid as far as possible making any special rates, except in cases of your largest customers.
DOUGLASS BURNETT.

W 11. Has any one found any legitimate objection to the system of charging for electric current known as the "Doherty Rate," as presented to the Cincinnati meeting in 1902?

Too complicated to be understood by most of your customers; and they will object to the capacity charge. Better fix a different price for each of several amounts of average daily use.
DOUGLASS BURNETT.

W 12. Should motors of all sizes get the same discount for the same hours' service?

No; small motors should pay a higher rate than large ones. Small motors compete with gasolene and gas engines only, while large ones compete with steam.

Below I give a motor-service rate just adopted by several plants in Central Texas, known as the "Kelley rate." It is applicable to intermittent or constant service, or to large or small motors.

First	100	kw-hours		at 10	cents	per	kw-hour
Next	200	"	or fraction	at 8	"	"	"
"	300	"	"	at 6	"	"	"
"	500	"	"	at 4	"	"	"
"	1,000	"	"	at 3.5	"	"	"

The remainder at three cents per kilowatt-hour.

This rate can be adjusted to suit different costs of production in different localities by changing the price per kilowatt-hour in each step. ELBERT D. KELLEY.

Theoretically, yes; but in practice under the capacity system have found that everything under 10 horse-power will stand one rate, and all over that size require another.

J. W. CARTWRIGHT, JR.

With reservations, the answer would be, yes. Long-hour business is the best, be it two horse-power or fifty, one light or a hundred. The consumer who uses his maximum demand for the longest number of hours is returning to the central station the greatest interest on its investment for that particular customer, consequently he should be treated better than the customer who ties up a large capacity and uses it but seldom, and especially at the peak. R. LOUIS LLOYD.

Our practice is to make a charge for power service irrespective of the size of the installation. We give a monthly discount proportional to the quantity used, but make no average hourly use of the motor installation. This plan has seemed to be more satisfactory than to adapt a special price for special power installation. C. A. L., N. Y. ED. CO.

In a general way, yes. DOUGLASS BURNETT.

Theoretically, no; but practically we find it to work best to give discount according to consumption.

AUGUSTA RY. AND ELEC. CO.

In the opinion of the writer they should not, because larger motors will naturally consume more kilowatt-hours of energy. At the same time, the factor of hours of service should be the greatest one in the establishment of the rate, and the difference in rates purely for quantity should be the lesser—only sufficient for the saving in general expense that will result from having one customer as against several small ones.

JOHN F. GILCHRIST.

W 13. Should not the small consumer that burns his light from sun to sun be entitled to a meter rate nearly as low, if not quite, as the large consumer that uses only a portion of his lights all night, but uses the full capacity during the peak?

Yes. F. ELLWOOD SMITH.

It looks like a fair proposition that not only the consumer who burns from "sun to sun," but all consumers who burn during that time, should have a rate much below that charged for peak lighting. W. P. HAZELTINE.

We think the consumer burning the greatest number of hours per lamp connected per month is in justice entitled to the lowest rate, for at that low rate he is undoubtedly the most profitable customer to the central station. J. S. WHITAKER.

A customer who uses a given amount continuously is the most desirable of customers and should be encouraged in every legitimate way. GEO. B. LAUDER.

Give your small commercial consumer who burns long hours a two-rate contract, which provides that the consumer pays for electric current for an average use of 60 hours per month of the lamps connected at 12.5 cents per unit, and for any current in excess of said average use of 60 hours per month of the lamps connected at six cents per unit. In consideration of the six-cent rate the consumer guarantees $2.50 for each arc lamp, and $3.00 for each 20 16-cp lamps per month.

THE COLORADO SPRINGS ELEC. CO.

In case noted, the smaller consumer is more desirable from view-point per unit of cost to render service.

G. WILBUR HUBLEY.

The long-hour small consumer should have a better rate than the short-hour large consumer coming in on peak.

A. PETERS.

Yes, if installation is in proportion. ANDREW F. HALL.

See answer to question W 12. R. LOUIS LLOYD.

One light burned 10 hours is worth to the station much more than 10 lights burned one hour, and such a favorable customer is entitled to the low rate. J. W. CARTWRIGHT, JR.

Yes; his rate should be lower if it can be worked out practically. AUGUSTA RY. AND ELEC. CO.

The small consumer who burns all-night lights is more desirable than the large consumer who uses current at the peak of the load. C. W. KOINER.

He might be entitled to a lower rate. DOUGLASS BURNETT.

Yes. On our sliding-scale rates the consumer who has the lower lamp count and burns all his lights all night will receive a lower average rate per kilowatt-hour than the consumer who has a large lamp count and burns only a portion of his lights all night. C. M. WRIGHT.

Taking into consideration all the costs of the small consumer, including the consumer costs, demand costs and current costs, it would seem, in the example given, that the small consumer would be entitled to a lower rate than the large consumer who used only a portion of his lights all night, but used the full capacity during the peak. FRANK W. FRUEAUFF.

W 14. Will some plant using maximum-demand meters give average, highest and lowest yearly maximum demand per 16-cp lamp or per kilowatt connected, for various classes of business; for instance, for residences, for lodging houses, for saloons, etc.?

The following information was obtained from figures for the South Side of Chicago. The figures given are for a period of twelve months. They are an average of a number of customers, and well represent the total business in any residence district of the city of Chicago.

WRIGHT DEMAND MAXIMUM PER CONNECTED KILOWATTS

	Highest Reading	Lowest Reading	Average Reading
Houses	.54	.25	.39
Flats	.62	.24	.42
Stores	.83	.57	.69
Saloons	.69	.39	.34
Average all business	.60	.29	.44

GEO. MCKANA.

W 15. How can we best push the electric-heating business?

Put out heating appliances ten to thirty days for trial. A 500-watt, five-pound laundry iron for a family of from two to four persons will only use from eight to 12 units a month.

THE COLORADO SPRINGS ELEC. CO.

By distributing circulars with bills and holding demonstrations in show-rooms. AUGUSTA RY. AND ELEC. CO.

We carry a small line of irons, heating pads, water heaters, and curling heaters, and have let our customers in on this by sending them advertising matter relative to the same. We have installed some flat-irons on trial, and they do not come back, as the customers are too well pleased. You will find that water heaters are very popular. Let your customers try them.

H. E. RYDER.

By reducing your rates on electricity. C. M. WRIGHT.

This company believes that the best way to push the electric-heating business is to make a display of heating apparatus in your show-room, and, if possible, in some restaurant, cooking school, or place that is more or less public, or in a department store, where some concession can be made to the proprietor to induce him to make this exhibit; also by advertising and getting pieces of efficient and rugged apparatus scattered somewhat generally through the residence section in the hands of people who are likely to let their neighbors know; also by the sale of the energy on the same basis as power, or on some favorable basis less than ordinary lighting rates—which is warranted under the prevailing conditions in most companies—in which case it would be necessary to install separate meters.

JOHN F. GILCHRIST.

W 16. (a) Should different rates be made for using heating and cooking appliances than for regular lighting? (b) Are such appliances connected on light meter or on a separate meter?

(a) Special meter installed and connection made for heating appliances on special rates at about double the regular minimum guarantee charge.

(b) Appliances in private families—such as chafing dishes, coffee urns, tea-kettle, hot-water heaters, heating pads and laundry irons—put on regular meter at regular rates. This is reasonable for customer and better for company.

THE COLORADO SPRINGS ELEC. CO.

Current for heating, cooking, and charging storage batteries. *et cætera,* should be delivered through a separate meter and at a lower rate than the lighting rate. The regular power rate can be applied to this class of business. F. ELLWOOD SMITH.

Where a great quantity of current is used for heating and cooking, we install a separate meter and grant a lower rate.

UNITED ELEC. LT. CO.

(a) Current sold for heating and cooking *must be* sold as low as you can afford to sell it per kilowatt-hour. One house that we know of cooks entirely by electricity, and used 150 kilowatt-hours in one month. At three cents per kilowatt this would just about equal gas at $1.40 per 1000 cubic feet.

(b) A separate meter should be used.

J. W. CARTWRIGHT, JR.

If the amount of business justifies it, separate rates and meters might be used. AUGUSTA RY. AND ELEC. CO.

Such appliances should be installed on separate meters and a lower rate should be charged than for lighting purposes, as most of this current would be used during the day when the machines are doing little work. I think this would help to build up a good day load, and would be a good way to push the electric heating and cooking business. C. M. WRIGHT.

W 17. What rates are used for heating service, and are any special rates made for this class of load?

On a 24-hour station service heating and cooking appliances are desirable, as most of them will be used during the day. A special rate is usually necessary to get the business.

THE COLORADO SPRINGS ELEC. CO.

See answer to Question W 16. F. ELLWOOD SMITH.

Special rates for heating and cooking must be made. As the average hours of house lighting are about two hours per day, and as cooking uses current, on an average, about four hours, current should be charged for at low rate. This only applies where a large amount of current-using apparatus is installed.

J. W. CARTWRIGHT, JR.

No special rate has been made. Heating appliances are not included in the recorded installation. This is equivalent to a special rate, in that the recorded installation appears on the bill as having been used longer by an amount equivalent to the heater consumption. The units consumed by the heater are thus charged for at the lowest rate that is obtained upon the particular bill in question. C. W. R., N. Y. ED. CO.

From such data as the writer has gathered, most companies seem to be furnishing heating devices at their regular lighting rates, although quite a few are selling current on their power schedule. Very few, if any, have a special rate for heating.

JOHN F. GILCHRIST.

W 18. What rates are used for charging storage batteries, and are any special rates made for this class of load?

See answer to Question W 16. F. ELLWOOD SMITH.

Usually special rates are given for this service, five cents per kilowatt-hour probably being average rate.

G. WILBUR HUBLEY.

Six cents per kilowatt-hour, with a minimum of $50 per month. Yes; this is a special rate for charging storage batteries.

E. A. N., N. Y. ED. CO.

W 19. Is it good practice to install electric signs on contract, making special rates for same and having same controlled by time switches?

I consider electric signs on not less than one-year contracts as good business. Think that rates should be based on free lamp renewals. A. C. GREENMAN.

Yes. G. H. CUSHMAN.

Put signs on a flat rate on long-hour running, four hours or more, and turn on and off by patrol system.

THE COLORADO SPRINGS ELEC. CO.

Yes. G. F. WILLARD.

Yes. G. WILBUR HUBLEY.

We would count it good practice, if it is long-hour service.

AUGUSTA RY. AND ELEC. CO.

Until the franchises were declared illegal, we found it excellent practice to make a fixed-rate contract on a weekly basis for a standard type of sign, to be equipped with lettering to suit the customer, and consisting of 24 4-cp lamps. A sign schedule of hours of burning was adopted for each month in the year, beginning within a half hour of dusk. Give the customer choice of burning until eleven o'clock instead of ten o'clock, and specify an increased charge for the extra burning. Fix your weekly price to include the return of the amount of your investment in two years, interest on the outstanding amounts, cost of franchise of sign, of wiring, the cost of the first equipment of lamps distributed through two years, the cost of lamp renewals, of the service, of the man to turn the sign on and off, of the current, and add 10 per cent for contingencies and profit.

DOUGLASS BURNETT.

We have found it a great aid to us in securing business to make contracts for electric signs, our plan being to figure the cost of the use of the sign from dusk until midnight, the rate charged each month being half the yearly rate. We send a man at dusk to turn on the sign and at midnight to turn it off, as our experience with time switches has not been altogether satisfactory. We have been able to get a great many users of light to change from meter rates, where they shut off the sign at eight or nine o'clock at night, to the contract plan. FRANK W. FRUEAUFF.

Meter each electric sign separately from all other lights and charge the regular meter rates, for each sign burns during the peak and few of them all night. But establish a minimum rate on each sign meter, covering an average of three to four hours' burning every night in the month; then they can use the sign as much longer any night as they wish, and you get pay for all that is used, while with the time switch there may be many nights the consumer would like to burn the sign later, but it is against the contract and the switch cuts them out. C. M. WRIGHT.

A great many instances of companies installing electric signs free on contract at flat rates per week have come to the notice of the writer, and every one who has really given the thing a thorough trial reports that it is exceedingly profitable. They may be controlled either by time switches or by patrolmen.

JOHN F. GILCHRIST.

W 20. What is the best method of proving to consumers paying at meter rates that they are not paying for more current than they are using?

I have a portable bank of 16-cp, 104-volt lamps, that aggregate 500 watts—by test. My meter man takes this bank of lamps and connects it in with the meter of the suspicious customer. With a Westinghouse single-phase voltmeter this 500-watt bank of lamps will move the pointer on the first dial one point, or one-tenth kilowatt, or 100 watts in twelve minutes. The customer can see for himself. It is the most practical demonstration that can be made. Give the customer a meter book. Tell him to note the hours his lamps burn—or an all-night lamp—and see what the meter reads. Let him understand that you want him to know all about it. Never try to fool a customer. A. H. KENNEDY.

(a) Show them how to read their own meters, and tell the meter man to dot down reading for them each month, so they can check for themselves.

(b) Employ only such men for meter readers as are extremely courteous and obliging.

(c) Ask if they would like to have an extra meter put in for a month, by which to check the accuracy of the one about which they have their doubts. If so, install one. We have done this in several instances, and in almost every case the new meter ran a trifle ahead of the old. We have never had a complaint from these people since. CHAS. H. PETERS.

Practical demonstration and test of meter.
G. WILBUR HUBLEY.

Teach the consumer how to read his meter. The only way to get the confidence of the public is to make no mystery of the matter, for you have nothing to conceal. Let them watch their meters while *one* lamp burns an hour, and if they have any sense at all they can soon be convinced that you are right—that is, of course, if *you* and *your meter* are right. R. LOUIS LLOYD.

See answer to U 4. Test meter in customer's presence either by volt-ammeter method, standard meter, or lamp-hour test. Sometimes it is advisable to install recording ammeters.
W. R. B., N. Y. ED. CO.

We have installed in our office an electric meter near our complaint window, the meter being covered with a glass case. A board is attached near it, having on it lamps of various candle-power. The consumer is shown how the meter is started and stopped by the turning on and off of the lamps and how with the larger sized lamps the speed of the meter is correspondingly greater. We believe another help is to have the consumer understand reading his meter so that he may check the figures taken by the meter reader. In some instances we put on a recording chart to show the consumer the hours when current is on and off—this to show him just when he is using the light. In many cases complaints come from people who do not realize how late their lights are burned. FRANK W. FRUEAUFF.

Inspire confidence in your meter system.
DOUGLASS BURNETT.

Demonstrate the effect on the meter of one, five, ten, *et cætera*, lamps in circuit and consumption over definite space of time with certain number of lamps. If doubtful on point of single-lamp consumption, show specifications of orders for lamps and prove by meter showing. L. W. EMERICK.

Teach them to read their own meters.
THOMAS. S. RICHARDSON.

W 21. What can be done to meet competition with gas engines? Has any company found it necessary to use special rates to keep out gas engines?

Gas-engine competition can be met by a good sliding scale of discounts, except in cases where the use is very short hours. With the usual load factors the gas engine is a very inefficient piece of apparatus. The 10 feet talked of generally becomes 20 in practice, at the very lowest, and this only by computation from the capacity of the engine, not from the loads actually carried. The gas engine is met upon the same ground as the steam engine, and we have all the advantages of the electric drive in our favor. We also have the advantages of a very simple form of prime mover as against the very complicated gas engine.

In large sizes and with producer gas the problem is not so simple, but if space and freedom from fire risks and smell are worth consideration, we have some good arguments.
THE PHILADELPHIA ELEC. CO.

Get knowledge of the use of current by various classes of machinery, and of the actual cost of power in such cases. Advertise your service, and maintain a good service, and make no special rates purely because of competition.

DOUGLASS BURNETT.

It is not generally necessary to make special rates to keep out gas engines. Small gas engines are so complicated and liable to so many troubles that are difficult of detection except to an expert, that the most effective solicitors for motors are the customers who have tried gas engines and have been shut down by the breaking of some small special part that required several weeks to replace, or that have had their gas engines shut down without apparent cause and have been unable to locate the trouble without getting an expert from the factory to locate the trouble. A good stock of motors of various sizes enables the lighting company to promptly replace gas engines that give trouble from any cause. Once the motor is in, no former gas-engine user will ever give it up unless the charges are exorbitant.

H. T. HARTMAN.

W 22. What system do you advocate for handling the business of the contracting department?

The employment of a contract agent whose business shall be exclusively the matter of getting load for the station. The lighting company in any town of 5000 people or more cannot afford to be without such a man. He, in a small place, can do the work himself, of seeing customers and keeping the records. In the larger places he must have solicitors in regular districts for covering the territory, and a chief clerk who shall talk with the general run of customers in the office, attend to the details of putting through contracts and seeing that they are properly executed, and keeping complete records of the business done, reports of solicitors, card systems of people on whom solicitors are calling for the purpose of following up, and so forth.

JOHN F. GILCHRIST.

W 23. What provision is made in existing contracts for tests on arc or incandescent lamps for street lighting?

Provision is made in contracts that the cities can test the current maintained on the series circuits for arc and incandescent street lighting, which they do at stated intervals, unknown to the company, and send us report on same.

F. C. S., MALDEN ELEC. CO.

This company has a contract for furnishing arc lamps for street lighting at Sycamore, Ill., in which contract provision is made for testing the arcs, the testing specified being a consumption of 450 watts at the arc, and that the lamps be rated as 2000 "nominal" candle-power. W. H. ZIMMERMAN.

"The company agrees that the Town may, at all times, with or without the Company's knowledge, employ a competent person to test the electrical currents and energy furnished to any or all of said lights, and to examine and test the street lights to ascertain whether or not the Company is complying with the terms of the contract, and for such purpose the Company agrees that such competent person may have access at all reasonable times to all said lights, poles, wires, fixtures and other apparatus of the Company in the streets and other public places in the Town and used in carrying out this contract. The Town agrees to indemnify and save harmless the Company against any and all claims for damages, loss, cost, and expense on account of injury to persons or property arising in any way out of the employment, act or neglect of such person. Should the Town at any time find that the Company is not complying fully with all the terms and requirements of this contract, the Town shall immediately notify the Company of such fact, so that the Company may at once remedy the fault." F. ELLWOOD SMITH.

Arc lamps tested by ammeter in circuit and voltmeter across the lamp terminals—lamp having been specified in these terms as corresponding to certain watts consumption. L. W. EMERICK.

W 24. Should a contract for incandescent street lights specify when the lamps should be renewed, either as to number of hours' burning or as to the minimum candle-power to be allowed?

The writer thinks not. As to the candle-power, we are limited to a minimum of 24-cp initial tests on 25-cp lights.

F. C. S., MALDEN ELEC. CO.

"Shall be promptly renewed by the Company whenever broken or burned-out or when the candle-power falls below 80 per cent of the normal." F. ELLWOOD SMITH.

Not if you can avoid it. FRED B. SHARPE.

In making street incandescent-lighting contract it is very desirable to specify the number of lamp renewals that will be allowed per year. If arrangements can be made to deliver the lamps to the municipality and have renewals made by the police, complaints of service will be more than halved.

H. T. HARTMAN.

W 25. Should a contract for incandescent street lights specify initial or average candle-power, and what is a satisfactory method of testing candle-power of street incandescent lamps?

(a) Average candle-power.

(b) Mount your photometer on the top of a wagon. Measure the lamp as it is in actual service. D. CLINTON SHAIN.

"The incandescent lights shall be the so-called 25 candle-power." F. ELLWOOD SMITH.

(a) Average candle-power.

(b) A good photometer. F. C. S., MALDEN ELEC. CO.

W 26. In wording a contract for street lighting, what is a fair description of a so-called "full arc," or a "2000-candle-

power" arc that will not be misunderstood and that will stand a fair test? Also a "half-arc," or a "1200-candle-power" arc?

All street-lighting contracts should specify the watts per lamp, instead of the candle-power. G. B. LELAND.

Designate the lamp according to the energy it consumes. For instance, we use the terms 350-watt, 450-watt, and 575-watt lamp.
GEO. MCKANA.

"The arc lights shall be of the 6.6-ampere alternating-current enclosed pattern, requiring an electrical energy of 422 watts on an average and not less than 410 watts in any case, or such modifications of the same as shall be practicable, provided the candle-power of the lights shall not be reduced."

"Said arc lights shall be the so-called 'half-arc' nominal 1200-cp lights, requiring an electrical energy of 310 watts and supplied with current of not less than 6.6 amperes."

"The electric current furnished shall never be less than 6.6 amperes and the potential fall of each lamp shall not be less than 45 volts." F. ELLWOOD SMITH.

Specify the watts to be furnished to lamps and avoid use of misnomer of nominal rating of 2000 candle-power and 1200 candle-power. G. WILBUR HUBLEY.

We think the wattage of the lamp should be given, followed by the words "2000-cp or 1200-cp nominal."
A. R. MCKINNON.

Normal 2000 or 1200-cp arc lamp requiring .... (state watts wish to serve) watts at the arc. C. C. GARTLAND.

The lamps should be designated in watts per hour and the word "candle-power" should be eliminated from all contracts made with cities or villages for street lighting. A fair description of a so-called 2000-cp arc lamp would be a lamp consuming 450 watts, and for a 1200-cp one consuming 350 watts. C. W. KOINER.

Get away from any "candle-power" reference whatever, and show frankly that it does not and never did mean anything. Explain that energy put into a lamp determines light given out, and that lamps are rated by energy consumed "at the lamp terminals," not at the *arc*. Power factor will not make trouble in that case.

L. W. EMERICK.

W 27. What is a fair method of settling disputes between companies and cities as to whether the company is actually furnishing 2000 or 1200-cp lights?

I have always used a portable voltmeter. We have the standard 450-watt enclosed arc. Have the proper officers see the voltmeter applied; with a 6-ampere lamp at 75 volts, the requisite 450 watts are secured.

In the first place, I never would agree to give 2000 or 1200 candle-power. That is where the trouble comes in. In our contract a 450-watt enclosed arc lamp was specified, and nothing was said about the candle-power. If the above won't satisfy the city, let it employ a reliable electrician to make the test.

A. H. KENNEDY.

If direct-current series lighting is used, a lamp consuming 490 watts, with a clear globe, is approximately equivalent to 2000 candle-power; in other words, an ammeter showing 9.8 amperes per lamp, and average pressure across lamp terminals of 50 volts. In enclosed alternating lamps, a consumption of 660 watts, with clear globe—*i. e.,* six amperes at 110 volts—gives approximately 2000 candle-power; or 385 watts are approximately equal to 1200 candle-power with clear globe. CHAS. H. PETERS.

If possible, get things to a basis of watts per lamp, with specified current in circuit. This is always readily determined. Present method of rating by lamp makers is based on watts consumption, which should help prove that candle-power rating is obsolete. L. W. EMERICK.

W 28. By the use of what argument and figures can a prospective consumer be convinced that an electric motor is cheaper than a steam engine?

By showing the comparative figures of installation and operation between steam and electricity if plant is not installed. If steam plant is installed, take consumer's figures of cost of maintenance of steam plant, including labor, coal, waste, oil, *et cætera,* and compare with purchase of motor and cost of current and maintenance. The price of motor may cause figures to appear high, but emphasis should be laid on the fact that a motor does not require the constant services of labor, as do engine and boiler.

MADISON LT. AND RY. CO.

Dr. Louis Bell, in *Electric Transmission of Power,* treats this subject exhaustively and presents facts and arguments in his characteristically able and convincing style.

RALPH D. LAXTON.

We first endeavor to arrive at the true cost of steam power to the prospective customer, and get him to agree with us upon a figure that properly represents it. We have found that when we have been able to figure the same upon a rational basis with him, the most convincing argument is a guarantee on our part that his bill will not exceed a certain specified amount per month. This amount ranges from about $4.00 per month per horse-power connected, upward, depending upon the service and conditions. The customer is further required to submit to a minimum of $2.50 per month per horse-power connected, and is told what our average income per horse-power is for his class of service.

ROCKLAND LIGHT AND POWER CO.

If a company can not convince a prospective customer by using actual facts and figures that it is cheaper to use electric motor for power than to use steam engine, it had better not install the motor, as such an installation would only result in dissatisfaction to both the customer and the company.

F. G. PROUTT.

Explain to him that it does not cost anything to start his motor, and that he does not lose anything after it is cut off, whereas, when he has a steam engine he has to raise steam, keep his boiler and engine in repair, run the risk of a fire, also an explosion, and serious accidents; and last, but not least, he is losing all the steam he has raised when he cuts the engine off, whereas on his motor he only pays for what he uses.

FRED M. LEGE, JR.

Because when the motor stops his expense ceases. The same argument applies before starting, while for the steam engine a certain amount of fuel is consumed to get up steam and in banking fires. Aside from this, a licensed engineer must be in charge of a steam engine; not so with a motor. Cost of oil, *et cætera,* should also be considered. E. A. BECHSTEIN.

We often find it a difficult matter, and have tried the following plan with success: To offer to install a motor on thirty days' trial and to remove it free of expense to the customer if not satisfactory. The company bears the expense up to the building, while the customer pays for any wiring inside of the building and whatever shafting and pulleys may be necessary. This will be a loss to him if he orders the motor removed. He also pays for the current during the trial at an agreed upon rate. Such an offer is a convincing argument, and we believe it pays to make it where you feel pretty well satisfied beforehand that the motor will be kept. ALEX. J. CAMPBELL.

By a trial, if you have motors in stock and can make installation without too great outlay of time or material.

D. O'CONNELL.

We have found that where a steam or gasolene engine could not be removed otherwise, the placing of a motor on trial, entirely without cost to the prospective consumer, and of donating a month's current service, has never failed to bring the customer. It may look extravagant, and should not be resorted to unless a person is sure that the motor service will either save expense or increase output of customer's manufacture, or other substantial advantage be gained. When the solicitor knows exactly what the prospective customer's steam plant can be made to do, he can figure to a certainty what the motor will do. The above-named procedure is sure to accomplish results. E. PETERSON.

Our way of talking to a prospective power consumer is, first, to convince him by figures that he does not average his maximum throughout his running hours; second, to analyze the figures of all existing power customers and show him the results obtained by some one in the same line of business using our power. In starting the power business it will of course frequently happen that we can not find a parallel case, and in an older business such will frequently be true. In such cases the central station is, we believe, warranted in making exceptional inducements, such as installation of motors upon agreement to take them back after a certain time at a very nominal charge for depreciation. Also to make certain guarantees for a limited time as to what the consumer's bills will be per installed horse-power, so as to enable the customer to make a trial of the electric service without, as he will express it, "putting his head in a noose." If a little engineering ability and common sense is displayed in installing the motors the result will nearly always be favorable to the central station. JOHN F. GILCHRIST.

W 29. What do you consider a fair week's work, either in lamps or income, for a solicitor?

I do not believe there should be any attempt made to fix the amount of the solicitor's work, either in lamps or income. The solicitors should be paid on the basis of the business they turn in. In other words, the more business they produce the more they should receive. With this thought in mind, the solicitor will be constantly at work and will have no thought of having done enough for the week, the incentive being that the more he does the more he can make. The average estimated yearly revenue turned in on the contracts taken by the solicitors employed by this company varies from $600 to $1000 per week, depending on the ability of the man, district in which he is employed, and the time of year. FRANK W. FRUEAUFF.

Preliminary or introductory work, as well as special work, on the part of the solicitor should not be charged up against his time, as the results of this kind of work come in the future. Outside of this, the business brought in directly and indirectly as the result of solicitation should result in a year to twice the amount paid to the solicitor in salary. Since several months in the year are quite non-productive of results, the yearly basis seems the only proper one. THE PHILADELPHIA ELEC. CO.

A fair week, month or year's work of a solicitor, in lamps or income, must always depend upon the district in which he works. A week can hardly be taken as a basis in any field, as under certain conditions and at certain seasons of the year it is not possible to get as much business as at others. The writer takes as a basis the gross 16-cp equivalents, as this is a much more practical unit than that of income, although the income is what really counts. He believes in using the lamp equivalent as the unit of the agent's work, and making inducements in other ways that will result in the agent's bending his efforts in the direction of the most profitable kind of business. This company has some solicitors of whom as low as 5000 lamps per year is expected, but if they get that number they will do as well as other lighting men in better districts getting 20,000 lamps per year and power solicitors getting 40,000 16-cp equivalents per year. We believe the proper method is to district your territory, then, by past results and all the information you can obtain, fix for each solicitor an amount of business that with good work that territory shall yield.

JOHN F. GILCHRIST.

Depends entirely upon local conditions.

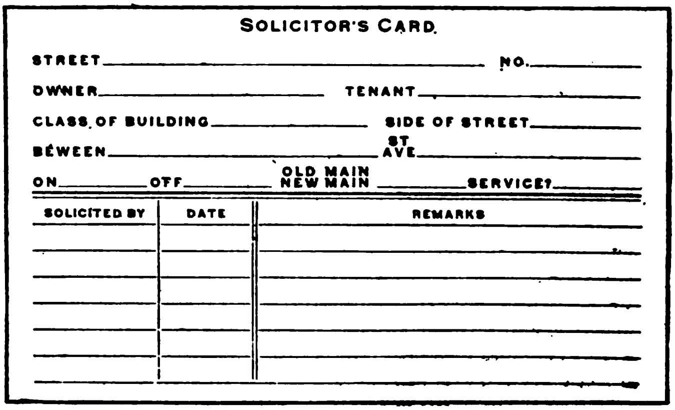
DOUGLASS BURNETT.

All he can get. Results vary at different seasons. In a town of 15,000 population one solicitor—paid $500—got 369 gas and electric consumers, a cost of $1.35 per consumer, which increased the income 22.5 per cent. R. N. KIMBALL.

W 30. (a) What methods do you use to save clerical work for solicitors? (b) What system of reports, if any, do you use to check solicitors' work and keep them up to their best efforts?

(a) Solicitors are required to do very little work of a clerical nature outside of making out their daily reports. (*b*) These reports, in the form of cards for an index system, are printed to show the address, character of premises, whether wired or not, and such further details as to enable the work to be followed up. One is made out for each place visited each day, serving as a complete check upon the work. THE PHILADELPHIA ELEC. CO.

We use the following form, which we file by streets.



SOLICITOR'S CARD.

STREET ____ NO. ____

OWNER ____ TENANT ____

CLASS OF BUILDING ____ SIDE OF STREET ____

BETWEEN ____ ST
AVE ____

ON ____ OFF ____ OLD MAIN
NEW MAIN ____ SERVICE? ____

SOLICITED BY	DATE	REMARKS

R. N. Kimball.

The only clerical work for solicitors is to see that contracts are properly written up, and contain information as to what the company is to do in the way of giving credits or rebates on changes of contract, or appliances to be furnished. A daily report of contracts signed should be made. Cards should be filled out giving names, address, *et cætera,* of prospective customers.

Douglass Burnett.

Use card system. Make solicitor turn in a card each evening for each place visited during the day, with party's name, street and house number, prospects of a sale, *et cætera.*

Charles D. Penniston.

Each solicitor is expected to keep a record of each visit made, showing the time spent at the place and results accomplished, if any; also class of contract he was attempting to secure. These reports are turned in each night and are tabulated to the house record by special clerks. The house card records are gone over frequently by a clerk, who calls the attention of the solicitor to places where he should call or where there seem to be opportunities for further business.

We have not aimed to cut out all of the clerical work of the solicitors, as we believe it necessary for them to keep a careful record of the business in their section, and while this takes up considerable time, we believe it is time well spent; otherwise their efforts may be misdirected. FRANK W. FRUEAUFF.

X

ACCOUNTING AND STATISTICS

X 1. Where can I get information concerning best methods of electric-light and telephone accounting and statistics?

For electric-light accounting, write the Engineering and Investment Company, 909 New York Life Building, Chicago, Ill. R. N. KIMBALL.

X 2. What is the best system of billing goods for wiring, current, etc.?

We use different forms for light service, power service, merchandise, wiring, *et cœtera,* with different-colored papers. In this way, if you do not allow discount on all these, you can so specify on each form, in a prominent place (we use the margin). If you put all items on one bill, customer is liable to take discount off the whole thing, and cause you much unnecessary work and annoyance. CHAS. H. PETERS.

X 3. What are some of the best ways of keeping rent or meter accounts?

Meter-reading cards, computation sheets for each customer, card index system for each customer, each card covering two years, with amounts in kilowatt-hours, and of bill also, showing payments. The reverse of this card may be arranged to hold the history of the customer, namely, complaints, tests, where previously served, *et cœtera.* THE PHILADELPHIA ELEC. CO.

Have special column in consumers' ledger for rental and add enough rental to charge for amount consumed to make up minimum bill. CHARLES D. PENNISTON.

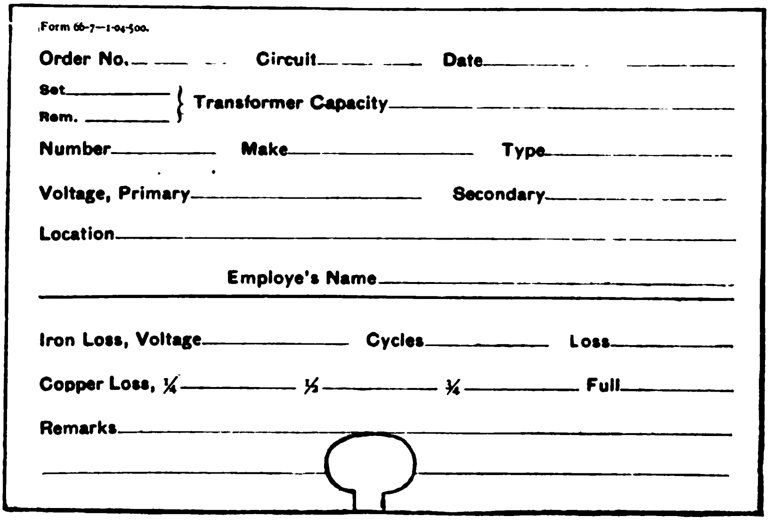
Customers' meter-reading cards bound in loose-leaf binders in order of streets and house numbers.

Customers' loose-leaf ledger, 25 accounts to the page, in same order as meter cards and on the safeguard account system plan.

Geo. E. Burns.

X 4. What is the best and easiest method of keeping a record of transformers and meters?

A convenient and easy method of keeping a transformer



Form 66-7—1-04-500.

Order No.______ Circuit______ Date______

Set______ / Rem.______ } Transformer Capacity______

Number______ Make______ Type______

Voltage, Primary______ Secondary______

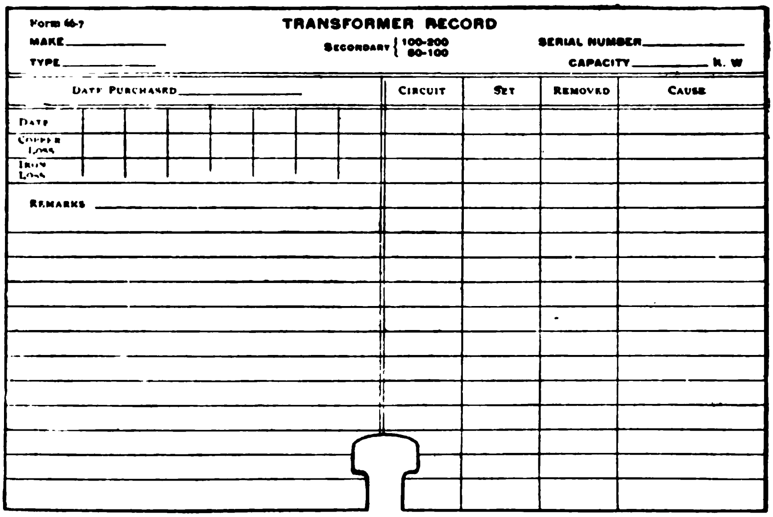
Location______

Employe's Name______

Iron Loss, Voltage______ Cycles______ Loss______

Copper Loss, ¼______ ½______ ¾______ Full______

Remarks______



Form 66-7

TRANSFORMER RECORD

MAKE______

TYPE______

Secondary { 100-200 / 60-100

SERIAL NUMBER______

CAPACITY______ K. W

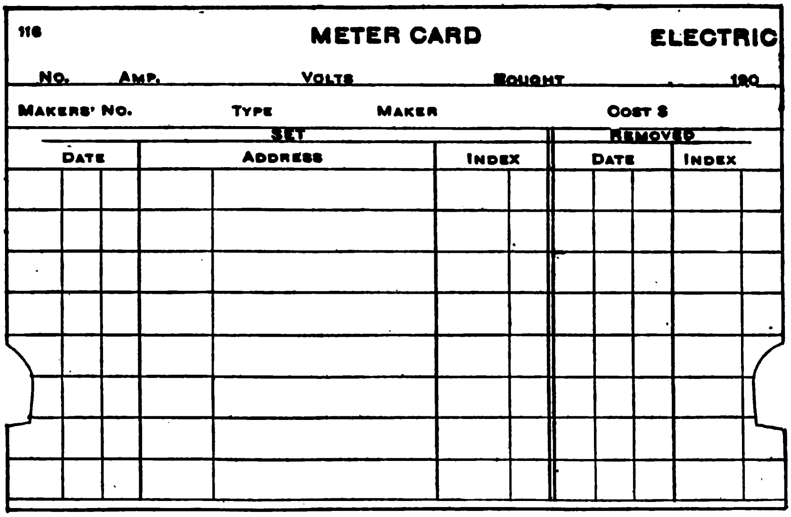
Date Purchased______

								Circuit	Set	Removed	Cause
Date											
Copper Loss											
Iron Loss											

Remarks______

record is by use of the card system, having a feeder index and a numerical index. In one case the cards for each feeder are grouped together, while in the other each make of transformer is grouped and the cards are arranged numerically. The sample cards will show the information on each. H. S. Russell.

I enclose a set of meter record cards which I think answer the

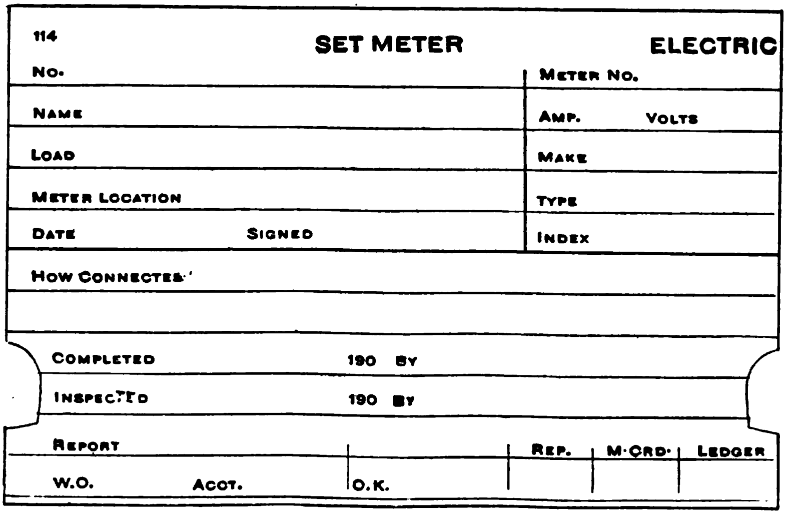


118 METER CARD ELECTRIC

No. Amp. Volts Bought 190

Makers' No. Type Maker Cost $

Set			Removed	
Date	Address	Index	Date	Index



114 SET METER ELECTRIC

No. | Meter No.

Name | Amp. Volts

Load | Make

Meter Location | Type

Date Signed | Index

How Connected

Completed 190 By

Inspected 190 By

Report		Rep.	M·Crd·	Ledger
W.O. Acct.	O.K.			

purpose admirably. By changing the wording they will also serve as transformer cards. A. C. GREENMAN.

Card catalogue. F. ELLWOOD SMITH.

X 5. What percentage of depreciation should be charged on station and equipment?

On brick or stone building, 2.5 per cent; on boilers and engines, 7 per cent; on dynamos, belting, *et cætera,* 8 per cent.
CHAS. H. PETERS.

Depreciation on station equipment should be written off at seven and a half per cent. C. W. KOINER.

X 6. What is considered a proper list of operating records for use in analyzing the operation of a steam plant? How much detail should be exhibited by these records in a 6000-kilowatt steam plant producing alternating current?

Daily records of all supplies such as coal, oil, waste, grease, *et cætera;* water, if purchased, or as a check upon evaporative results.

Records of pressure, temperatures and vacuum, by recording gauges. Records of engine and boiler service with a chart showing the load in relation thereto at least once a week.

Chief to carry his own log book showing all work done, all troubles, cause and remedy.

It is assumed that the accounting system would carry the details of operating subdivided into at least the following items: Payroll, engine-room and boiler-room, oils, machinery, cylinder and grease, waste, engines, miscellaneous, packing, belts, shafting, condensers, boilers, miscellaneous, tubes and caps, furnaces, pipes, pumps, blowers and heaters, coal apparatus. Executive and general expenses to be covered by the rest of the system of bookkeeping. THE PHILADELPHIA ELEC. CO.

It appears to me that, as a general thing, operating records go into far too much detail. Unless there is a competent man who has nothing else to do but follow up and analyze the records from day to day, nothing is gained by too much detail. On the other hand, the consciousness that the paper work, which requires so much of the time of the operating force, is simply received and filed away is very likely to make the men careless. I believe that the daily station records should be confined to the simple, salient points and that any unusual variation should be made the subject of a special test.

H. T. HARTMAN.

See headings on balance sheet.

LIBERTY LIGHT AND POWER CO., Liberty, N. Y.

Business Statement and Balance Sheet, month ending............................. 190

Business Statement	Amt.	Amt.	Per Watt
EXPENDITURES			
MANUFACTURE OF CURRENT			
Fuel			
Oil, Grease and Waste			
Other Material			
Labor			
DISTRIBUTING EXPENSE			
Lamp Renewals			
Other Material			
Labor			
GENERAL EXPENSE			
Salaries			
Commissions			
Fixed Charges			
Sundries			
REPAIRS AND RENEWALS			
Power Plant Building			
Steam Plant			
Machinery and Apparatus			
Pole Lines and Installations			
EARNINGS			
Lighting and Power			
Profit on Wiring Contracts			
Less Rebates, Discounts, etc.			
Profit for Month			
Profit Previously Reported			
Total Profit to Date			

Balance Sheet	Amt.	Amt.
RESOURCES		
Plant Account		
Tool Account		
Additions and Extensions to Plant		
Material Stores		
Fuel Stock		
Unfinished Wiring Contracts		
Accounts Receivable		
Cash		
LIABILITIES		
Capital Stock		
Profit and Loss		
Accounts Payable		

Number of Customers last Report

New Customers this Month

Lost Customers this Month

Number of Customers end of Month

REMARKS

FRED B. SHARPE.

X 7. What success has been obtained in devising and maintaining a systematic method of recording and satisfactorily analyzing all cases of trouble in the operation of central-station systems?

X 8. What is the average output per pound of coal (stating kind used) in plants using compound engines; size of plant 2000 to 5000-kilowatt?

The average output per pound of coal for station using Illinois nut and screenings is 0.120 kilowatt-hour; and for station using West Virginia smokeless coal, 0.165 kilowatt-hour.

Geo. McKana.

From three to four pounds of coal per kilowatt-hour.

C. W. Koiner.

X 9. What percentage of total generated output is lost or unaccounted for and what is the percentage of each of the classes of such losses or unaccounted-for current?

In modern central-station systems, generating 25-cycle high-tension current and supplying direct-current and alternating-current 60-cycle service by means of rotary converter and motor-generator substations, respectively, the annual loss between generator terminals and service meters is about 33 per cent of kilowatt-hours generated.

This loss may be subdivided as follows:

	Per Cent of Kw-hours at Machine Terminals
(1) From generator to substation feeder-board.	
Transmission and substation conversion losses	15 per cent
Storage battery and booster losses	1 " "
Total	16 " "
(2) From substation feeder-board to service meter.	

	DIRECT-CURRENT SYSTEM Per Cent of Kw-hours at Feeder-board	ALTERNATING-CURRENT SYSTEM Per Cent of Kw hours at Feeder-board
Copper or line losses	8 per cent	8½ per cent
Wattmeter shunt	1 "	1½ "
Transformer loss	.. "	12½ "
Unaccounted for	9½ "	7 "
Total	18½ "	29½ "

Average, direct-current and alternating-current systems, 20.5 per cent.

Also see answers to question T 9, 1904 *Question Box*.
S. PRUSINOWSKI.

X 10. In an Edison three-wire, overhead, direct-current, 110-220-volt system, with mains interconnected and feeders arranged to give good regulation of voltage, about what per cent is lost between station meters and consumers' meters?

Good practice may vary from 15 to 25 per cent for all, including unaccounted-for losses. The best net result for any one case is determined by balancing the fixed charge on investment needed to reduce loss against actual cost of supplying such energy loss. P. JUNKERSFELD.

Our average is about 24 per cent. A. PETERS.

Twenty-five to 30 per cent; 25 per cent being very good.
E. B. GREENE.

X 11. What is the best method of keeping record of connected load?

Connected load can be conveniently carried in a specially ruled book dividing the business up into the various classes, such as arc, incandescent, power, incandescent arc, and Nernst. Names and load of each customer entered from the installation slips, in black ink.

Names and load of customers going off the system entered from the slips showing disconnection and cause, in red ink.

Enter the loss after those gained, subtract the amount and carry the balance ahead the same as any other entries.
THE PHILADELPHIA ELEC. CO.

Have the customer's connected load on his meter card, together with the number and size of his meter, and have the meter men when they read meters ask or see if installation has any change; if so note it on the meter card, then check up customer's card index system in the office with the meter cards.
F. W. BULLOCK.

Issue numbered cut-in and cut-out orders, and keep a card index arranged geographically according to the streets, the order number, and the installation, and the date of cut-in or cut-out. Keep a weekly summary of changes. DOUGLASS BURNETT.

In connection with our engineering department, we have a series of cards showing the connected load on each feeder and each transformer. When a house is connected the amount of installation is posted to the feeder record and to the transformer record and a card arranged for the house, so that by reference to this record we at all times know the connected load on each feeder and on each transformer, and also just what the installation is at each house. When the house is disconnected this amount is deducted from the load on the feeder and transformer.

FRANK W. FRUEAUFF.

Probably the best method of keeping connected-load records is to use a book with columns for date, consumer's name and address, the various sizes of electric lamps, number and horse-power of motors and total horse-power, fans, meters, and several columns for miscellaneous devices. The results of a careful census are entered on the first line under each of the above headings. Additional customers' names and installations are entered in black, and those of customers leaving the system are entered in red. The totals in black and those in red are recorded separately at the bottom of the page and carried forward to the next page up to the end of the month, when the totals in red are subtracted from those in black, the result forming a starting point for the next month.

H. T. HARTMAN.

X 12. Is it not better to have the consumers' ledger segregated according to meter route, rather than alphabetically?

This is our practice, and we favor it. P. H. KORST.

Consumers' ledger should be arranged according to meter route. CLAYTON GEIGER.

Posting is facilitated by having consumers' ledger arranged according to meter route, but in this case every consumer should have a number, so that his place in the ledger can be readily found. H. J. MEYER.

Yes. F. ELLWOOD SMITH.

An arrangement that I have found very successful is as follows:

All names in my ledger are in alphabetical order. I have the meters divided into three routes, with a book for each route. These books are also arranged alphabetically and on each page is the number of the ledger page on which that account is to be found; there is no jumping back and forth when I am transferring from the meter book to the ledger; I can see at a glance to which page of the ledger to turn, and still the arrangement of the ledger is not disturbed.

I also carry my index along from page to page; the pages of the meter book are all numbered, and on each page I have in small red figures the number of the page on which is found the next meter to be read. It is the easiest method I have ever tried, far better than having the meter books arranged in the order in which you are going to visit the meters, because it is so easy when you come to do your book work. EAST RIVER ELEC. CO.,
PER BOOKKEEPER.

Yes; have your consumers' ledger segregated according to meter route and use a regular index, as this will enable you to enter your bills more rapidly and you are not so much subject to errors as you would be otherwise. Your index will enable you to locate your consumers, as you will undoubtedly have them numbered.

I think you will find it good policy to run your meter reader's books in regular route, also your transfer meter record, as by the use of the loose-leaf system you can easily keep them straight; or, easier yet, use an addressograph and route it the same as your meter reader's book, and you will find it a very rapid way of running off your bills and then making your transfer.

FRED M. LEGE, JR.

According to meter route; then have an independent card index of your customers for reference, and arrange your meter trips in accordance with feeders or stations, or both, to enable you to make a comparison between kilowatt-hours billed and kilowatt-hours generated. DOUGLASS BURNETT.

Yes, decidedly. ALEX. J. CAMPBELL.

Years of practical experience, first with latter and afterward with former system, cause me to answer emphatically, Yes, if by "according to meter route" is meant street number. Small plants may, perhaps, use the alphabetical system to better advantage, but with a material number of accounts I would advocate segregating by street number with customers' ledger used in printed form, allowing two years with five changes of tenants to each street number, and make meter route conform to ledger.

J. W. CLAPP.

Yes; because when consumers' ledger is segregated according to meter route it facilitates the posting to ledger of amount due from customer, as the meter sheets are written up according to routes or days.

The bookkeeper can locate an account practically as well, knowing the address of customer, as if ledger were arranged alphabetically. T. J. WALSH.

In electric plants of any size, we believe it absolutely necessary to route consumers' ledger according to streets rather than alphabetically, as very much time is saved in posting and in the making of bills. It is also much easier for reference. We have our contracts arranged alphabetically, while our accounts on the books are arranged geographically, so that it is easy to locate a consumer if we only know his name, or find the name of a consumer if we only know the house number. Much time can be saved by running the ledger geographically.

FRANK W. FRUEAUFF.

Y

MANAGEMENT

Y 1. (a) Is a day service justifiable in a small town, and what kind of power business can be worked up; (b) what kind of power rate should be charged?

No. CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

This question brings up the ever-present "lap-load." I would advise any company in seeking power business to be very careful not to take on power that will lap over into the lighting period too much in winter. In a small plant, where this question has never been taken into consideration, this may seem improbable, but it is a situation to be avoided if possible, as it necessitates too much idle apparatus. GEO. B. LAUDER.

We have serious doubts about day service being justified in any small town by the income derived unless contracts can be made with a number of power users who will use power regularly every day. The class of business that is generally available is intermittent service or very small users, and even at a relatively high rate the total income will not be sufficient to warrant the extra expense for labor, fuel and depreciation. Where motors are very small or the use is intermittent, a 10-cent rate should be low enough and a five-cent rate should be the very lowest limit.

F. L. WILLIAMSON & CO.

It depends entirely on whether it is a residential or a manufacturing town. If the latter, writer thinks it is justifiable to run day service, which generally leads to a power business. As to the rate, it depends entirely on the hours the power is to be used and also upon the operating expenses of the plant.

F. C. S., MALDEN ELEC. CO.

All kinds of steam plants could be tested to see the cost of operation for comparison with electric motors.

AUGUSTA RY. AND ELEC. CO.

It depends upon local conditions. In the average small town, under 5000 population, it does not pay. C. W. KOINER.

(a) It is justifiable when you can get sufficient business to pay expenses and a reasonable profit. (b) You will have to figure your power rates from your expenses. If you have a sliding schedule, taking into account as a justification of reduced rates the average hours of daily use per lamp, adopt the same schedule, less the cost of lamp renewals. DOUGLASS BURNETT.

Y 2. (a) What has been the experience of central stations in thawing out frozen water pipes? (b) How was the current limited to what the apparatus would stand?

During the past winter we have done a very profitable business in thawing frozen pipes. This work was begun as an experiment, also to accommodate a very good customer who had been without water at his residence for a week or more. The success of the scheme was more than we anticipated. We at first fitted up a rheostat and used it with a voltmeter and an ammeter. We discarded this outfit after a short time in favor of the water barrel.

The operator usually gauged the current by the temperature of the wire between the barrel and the pipe. (This was first determined by the ammeter.) In the direct-current district the water barrel was the only apparatus necessary. In the alternating-current district we used a 15-kw, 2000-100 transformer, using our water barrel for controller. Our secondary main was a No. 4. The majority of the pipes were 0.75-inch; several were 0.5-inch. One was a five-inch main, supplying an automatic sprinkler system. There was also a 1.5-inch main 500 feet in length, supplying several dwellings.

We make a standard charge of $7.50 for each pipe. Where two houses are on the same service we make a reduction. In fact, we usually charge to suit the conditions, depending upon the time necessary to get our apparatus connected. Some pipes would cost $5.00; some $15. We averaged—after deducting entire labor charge—something over 50 cents per kilowatt-hour.

A very nice arrangement for this work would be to have a 10-kw transformer, the secondary wound for 50-100-200 volts. This could be used for regular work in case of emergency. Then wind a reactance coil for 250 amperes. This coil would be the only part of the investment chargeable to this special work. There is no doubt that this practice of thawing water pipes can not only be made profitable to electric companies, but the public would be willing to pay a good price for the service, as the expense involved in digging up frozen ground usually runs into large figures, to say nothing of having the street and pavement torn up for several months. D. CLINTON SHAIN.

Our experience has been that it is very profitable and satisfactory. We have a complete outfit for this work, using alternating current at 55 volts, which we control by reactive coils in the secondaries from transformers. With this pressure, any ordinary 0.75-inch iron service pipe about 125 feet long will thaw out with 135 amperes in from four to eight minutes. CHAS. H. PETERS.

In thawing out water pipes we have used an automobile-charging rheostat for a short run of small pipe. Where larger amount of current is necessary we have used water rheostat. Our service is direct-current, 110 and 220 volt.

F. L. WILLIAMSON & CO.

The central stations that have judiciously executed work in thawing out frozen water pipes have found it quite profitable. It is necessary to use judgment in the work, or damage to property may result. Limiting the current is readily accomplished by using a suitable rheostat. An ampere meter ought to be in circuit so that the current flow may be constantly observed, and judgment should be applied in determining how much current may be safely used at any particular place. DUGALD C. JACKSON.

The experience of two seasons shows the electrical method to be the quickest and the cheapest way for the work to be done. The results were satisfactory. When the current was taken from the system a water rheostat was used to regulate the current. When storage cells were used they were variously connected so that different voltages could be applied to the frozen pipe.

C. W. R., N. Y. ED. CO.

Y 3. Will a small central station operating 1100 to 52 volts, 125 cycles, be warranted in changing over to 2200, 230-115 volts, 60 cycles, when transformers are all old, but wattmeters comparatively new (commutator type)? Power business of little consequence; no day circuit at present.

Yes; such a station would be warranted in changing from 1100-55 volts to 2200-230-115 volts, and from 125 cycles to 60 cycles, for the following reason: With the same amount of wire in primary lines, practically twice the amount of current could be carried with the same drop; the reactive effect would be also reduced. A lot of small old-type transformers are anything but economical to operate, and any wattmeter built for 55 volts should be capable of standing 110 to 115 volts without injury, or the voltage coils could be changed at small expense.

Cost of new transformers, each capable of feeding a block or two both ways, and cost of three-wire secondary, would be more than offset by the advantages gained. CHAS. H. PETERS.

Yes, if plant is a growing one.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

If the station is small, the outlying distances can not be great, therefore why not scrap the transformers if very old? if not, place primaries of two transformers in multiple and secondaries in series, getting 104 volts, and use two-wire secondaries instead of three-wire as proposed. If transformers are worthless, and 1100-volt generator is in good shape, get new transformers to give you 100 volts or 104 volts and have armature circuits of wattmeters changed for 104 volts, or, if two old transformers are used to give 104 volts, run a 52-volt wire out of centre of secondaries and connect armature from one side to this wire. This will give half the voltage on armature, and by multiplying reading by constant 2 you will get things about right. A. PETERS.

Transformers could be purchased for low frequency or high frequency without other changes at the present time.
AUGUSTA RY. AND ELEC. CO.

Should not change frequency, but should purchase new type low-frequency, 60-cycle transformers and weed out the smaller ones gradually, making the secondary 52-104 volts three-wire. No advantage in 60 cycles for lighting over 125, and transformers more efficient at 125. GEO. N. TIDD.

Where power or inductive load is little used, there is little gained by changing from 125 to 60 cycles. The voltage should be gradually brought up to 230-115-volt, which can be done with present primary voltage, and all transformers changed if excessive core loss demands. The 50-volt (commutator type) meters can be changed to 100-volt at a cost of $6.00 each. R. V. WEST.

Y 4. What is the practice in inspecting wiring in a house wired when built, but to which current is not supplied until several years later? What charge, if any, should be made to the customer?

We inspect for insurance company, but make no charge; simply record result of inspection.

AUGUSTA RY. AND ELEC. CO.

Follow the National Code, and maintain an inspection system, unless that is provided for by the municipality or underwriters, or both. DOUGLASS BURNETT.

The practice would largely depend upon the requirements of the local underwriters' association. The practice in Philadelphia is to have the company's inspector examine the wiring and test for grounds, *et cætera,* and advise the consumer of any necessary changes that must be made, or make the changes at the consumer's expense. A reinspection by the Underwriters' association is usually necessary; the cost of such inspection is paid by the consumer. THE PHILADELPHIA ELEC. CO.

No charge. F. C. S., MALDEN ELEC. CO.

Y 5. In a town of 10,000 people, should a lighting company do house wiring and deal in fixtures?

By all means; and do your wiring, and sell your fixtures at cost. When wiring is left to small contractors, they naturally figure upon wire just large enough for present requirements, when, if town is growing, increased demand for light, such as enclosed arcs, would be liable to overload wires, and the lighting company has to listen to endless kicks about poor lights, *et cætera,* to say nothing of danger from wires overheating. By wiring at cost, the lighting company can make ample provision for additional lights, which is to its advantage in the near future. In larger cities, inspectors see that wiring complies with their requirements, and in such cases it is better for wiring contractors to do the work. CHAS. H. PETERS.

If the lighting company can not get business without doing this, I should think that it would be advisable to do so.

F. C. S., MALDEN ELEC. CO.

By all means, unless it would be to the detriment of a real live wiring and supply house already established there.

A. C. GREENMAN.

Our town, Corsicana, Texas, has just about 10,000 inhabitants, and we have found it not only necessary, but eminently to our advantage to do wiring. There is so little to be done that an independent supply dealer could hardly afford to be honest and remain in business, and the company would reap the benefit of what misdeeds he might be guilty of. We have been through this. W. H. THOMSON, JR.

We find it much to our advantage to do so.

A. R. MACKINNON.

If it is necessary to push the business and keep charges within reason. AUGUSTA RY. AND ELEC. CO.

In a town of 10,000 a good method of getting business would be for the company to do wiring and sell fixtures on the installment plan. That is, should a prospective customer desire service, whose house had not been wired and who did not feel like spending the amount at one time necessary to wire the house, the company should make an estimate on cost of doing the work, allowing the customer to pay a small amount down and the balance

in monthly installments, but the company should not do the work itself but rather let it out by contract to some local wiring concern.
F. G. PROUTT.

No. C. M. WRIGHT.

No. Throw it to a good wiring and supply man, who will in turn develop business for the central station.
L. W. EMERICK.

Y 6. Is it advisable to charge a 5-per-cent penalty for non-payment of bills within ten days from date?

No; it can not be collected legally. Experience has proven this. J. T. COWLING.

This company finds it advisable to charge at least a 10 per cent penalty for non-payment of bills after ten days from date.
W. H. ZIMMERMAN.

In this state (Pennsylvania) it has been adjudged unlawful to collect a penalty for tardy payment of a water bill, metered service. We, therefore, doubt if a five per cent penalty could lawfully be collected anywhere. It is much better to allow a discount for prompt payment, fixing the rate to correspond to the added penalty. R. LOUIS LLOYD.

It is illegal to charge penalty for non-payment of bill. Better raise rates and give discount for cash payment.
AUGUSTA RY. AND ELEC. CO.

I believe that a cash discount of ten per cent allowed on or before the 15th of the month is a most satisfactory method of bringing about prompt collections. R. V. WEST.

No, it is not advisable to charge any penalty for non-payment of bills, but it certainly is advisable to give a discount of five per cent or even ten per cent for payment in ten days. We find it has made a great difference in our collections. S. R. INCH.

No; eliminate bad accounts. DOUGLASS BURNETT.

Y 7. (a) What amount per 16-cp equivalent of new business obtained do you spend for soliciting and for advertising? (b) Would you consider it advisable to increase or to decrease either or both of these items?

Y 8. (a) Do you charge for cutting of wires in connection with moving of houses? (b) Do you collect damages for shut-downs? (c) Have you ordinances regulating moving of houses?

All time over two hours is charged for at each crossing.
FRED H. BECK.

We have city ordinances governing the moving of houses, in which the house-mover notifies the electric company and the electric company is compelled to cut its wires and again make repairs, but at the expense of the house-mover.
THE COLORADO SPRINGS ELEC. CO.

We have no ordinance in Corsicana regarding house-moving, but have consistently collected for all work done letting house-movers through leads and have charged for shut-downs when unable to prevent them. W. H. THOMSON, JR.

We always move our wires free of charge, when in the way of moving buildings or the taking down of trees.
G. B. LELAND.

The owner or contractor should sign an agreement promising to repay the company for the actual expense incurred caring for the company's wires. The company should be paid for the loss incurred by such shut-downs. Some street-lighting contracts provide that the company shall cut its wires and allow for moving buildings, but the person moving the building must repay the company this expense. At least one city refuses to issue a permit for the moving of buildings until satisfactory arrangements have been made with the company for caring for these wires.
F. ELLWOOD SMITH.

We always charge for this work, but have not been able to collect a single bill. An ordinance was passed but was found to be defective and could not be enforced. L. E. WATSON.

According to the laws of Massachusetts any building-mover or owner who wants to move a building, or cut wires, or remove poles, or both, *et cætera,* may do so at his own expense, providing that he has given the company twenty-four hours' notice, in writing, to the effect that he desires to do so, at the company's office, or has deposited such a statement in the post-office, properly prepaid, and directed to the company at its office, three days before the day or night on which he wishes to cut the wires or remove the poles.

In case a building-mover or owner wishes to remove our wires to permit of a building-moving operation he may do so, providing he has notified the company's office in writing, as per the statute, not by word of mouth or by telephone, ***but in writing*** to that effect, at his own expense and risk. If, however, the wires and poles are cut or removed contrary to the law, the party having charge of the building operations is subject to a punishment by a fine of not more than $500 or by imprisonment of not more than two years, or by both such fine and imprisonment.

How to Proceed on Such a Case

Upon receipt of written or other notice from the building-mover or owner, notify the building-mover and owner, in writing, that we will cut the wires or poles, charging him the actual cost to us of so doing, providing he will pay in advance a sum sufficiently large to cover all expense and will sign a paper which we will provide agreeing to pay for all subsequent damages.

Should the building-mover or owner refuse to pay the costs in advance or to sign the agreement to assume all subsequent damages and should he decide to cut the wires and poles at his own expense our linemen are to be sent to the spot when the wires are to be cut. Our linemen are not to assist in any manner in cutting the wires and poles or replacing same, but are to repair any damage that may be done; that is to say, should the building-mover or owner after cutting the wires and moving the building refuse or fail to put back the wires the company's men are to put them back themselves after first having inquired of the building-mover or owner his intention regarding same.

F. C. S., MALDEN ELEC. Co.

Y 9. An electric-lighting company has a 20-year franchise granting the right to use one side of the alleys for erection of its pole lines. Has any other company, either lighting, telephone or telegraph, the lawful right to use the same side of the alley by placing its poles between the wires of the first-mentioned company after said company has had its pole line erected and in operation? What is the experience of others in regard to such interference?

If a second company has received a franchise to erect poles and string wires, it would seem that first company did not receive an exclusive franchise, and therefore is apparently unable to prevent second company from erecting poles between its wires, and stringing wires above or below them. Of course, first company should be able to claim damages for any injury done to its poles, wires, or service by second company. The point at issue would appear to be—did the city grant the first company a definite side of the alleys on which to erect poles and string wires, or simply say "one" side? If the former, it would seem to imply an exclusive franchise; if the latter it would appear to be open to question.

CHAS. H. PETERS.

If the old company can prove that the new company has injured its property, limited its capacity, or in any way endangered its service or its employees, the courts would doubtless give it redress. Otherwise there would seem to be no recourse.

H. T. HARTMAN.

Y 10. Which is better practice—to charge for the fittings of the Meridian lamp or furnish them free?

We furnish the Meridian lamp and the fittings free of charge.

UNITED ELEC. LT. CO.

We charge for the first complete Meridian lamp, then renew free. This can only be done, however, when you get full-rated life from the lamps. J. W. CARTWRIGHT, JR.

Charge for the fittings. DOUGLASS BURNETT.

It is customary to charge for the fittings and the first installation of Meridian lamps and furnish part of the renewals free, or all of them, depending upon the price received for current. C. W. KOINER.

Charge the consumer cost price and nine out of every ten will think just as much of the company as though you installed them free, for as a rule, they figure that when a company gives them something for nothing, there must be something wrong and that they may be charged for it two or three times on their light. C. M. WRIGHT.

Y 11. Who pays for the street connection, the light company or the consumer; that is, what is the prevailing rule?

The lighting company, as a rule, pays for the street connections. MADISON LT. AND RY. CO.

Street connection without charge to consumer, but a service charge made of $2.00 if service is discontinued before three months. THE COLORADO SPRINGS ELEC. CO.

Lighting company should stand expense of connection from street to buildings. CHAS. H. PETERS.

In our case the company, which the writer thinks is the prevailing rule. F. C. S., MALDEN ELEC. CO.

It is the rule of this company to install meters and pay for street connection. W. H. ZIMMERMAN.

We run wires to house free and connect to wires brought out by contractor. ANDREW F. HALL.

The company does the connecting. J. F. DOSTAL.

We provide street connection without any expense to the customer. UNITED ELEC. LT. CO.

The light company generally owns the service wires up to and including the meter. L. E. WATSON.

The company should pay for the street connection in practically all cases and do everything else that may be necessary to induce customers to use current. F. G. PROUTT.

The lighting company. F. W. BULLOCK.

The lighting company should own all service wires up to the building, as they are a part of your system and you have a franchise for the privilege of placing same, while the consumer has not. E. A. BECHSTEIN.

The company, if it is awake and after business.
R. V. WEST.

The company should run service connections and set the meters at its own expense. This is the common rule.
C. W. KOINER.

Y 12. (a) Is it common practice among central-station managers to furnish free arc lamps on their commercial lines—i. e., the company pays the purchase price and the arc lamps remain the property of the company? (b) Are they as a rule put on flat or meter rate, and what is the usual rate charged on either?

(a) We furnish the arc lamps and repairs on the same free of charge. (b) Generally on a meter basis, at the same rate as incandescent lighting. THE COLORADO SPRINGS ELEC. CO.

(a) We furnish arc lamps without charge for the lamp and it remains the property of the company. The wiring, however, is paid for by the consumer. (b) As we operate night and day, all arc lamps are on meters at the regular commercial rate.

F. L. WILLIAMSON & CO.

(a) Yes. (b) Entirely meter rate.

F. C. S., MALDEN ELEC. CO.

This company has a rate at which it rents arc lamps on commercial lines, the charge being 50 cents per month, either on flat-rate or meter rate. W. H. ZIMMERMAN.

(a) We supply arc lamps to consumers free, they paying for wiring, *et cætera.* (b) We keep lamps trimmed and in good shape and charge meter rate; twelve and a half cents per kilowatt-hour for first 50 hours per month, then seven cents per kilowatt-hour. A. PETERS.

We install arc lamps free and charge regular rates subject to discount for amount used as registered by meter.

ANDREW F. HALL.

(a) The company owns the lamps and installs them. (b) They should be put on a flat-rate or else on a meter rate with a minimum or trimming charge. J. F. DOSTAL.

Lighting company buys and controls arc lamps with a view of building up a business. The matter of installation on this class of business should certainly be of a free character to the customer. C. C. GARTLAND.

To induce business it has been found advantageous for the company to furnish arc lamps on a minimum monthly charge of $3.00 where current is sold by meter. Commercial arc lighting is usually handled by meter—occasionally flat-rates; rates governed entirely by local conditions. R. V. WEST.

It is common practice for the company to purchase the arc lamps and retain ownership of same. The alternating-current arcs, which are mostly used now, are as a rule placed on meter rates, while the direct-current series arcs are placed on flat-rates; though the latter are little used now for commercial lighting.

C. M. Wright.

As this placing of lamps on the lines and renewing them without charge and renewing them is a special service, and represents discrimination, there might well be a separate charge, though in practice it seems better to cover this merely by means of a minimum charge of, say, a dollar per lamp per month.

Douglass Burnett.

Y 13. Under what conditions is a small central station at present equipped with 133-cycle apparatus, justified in changing over to 60-cycle?

With a steadily increasing load, and especially with an inductive load such as is caused by small motors and arc lamps, the reactive drop in lines on 133 cycles might become a serious factor, and under such conditions a company would be justified in making the change. It should also be remembered that small motors operate more satisfactory on 60 cycles single-phase, than on 133 cycles single-phase. On the other hand, Nernst lamps appear to have a longer life on 133 cycles than on 60 cycles.

Chas. H. Peters.

Do not know of any reason whereby a company would be justified in making this change, unless they could get considerable motor load. F. C. S., Malden Elec. Co.

Only in case a power load can be worked up.

G. B. Leland.

Y 14. What particular characteristics as to age, temperament and education do you consider most desirable and practicable in men for operating stations and substations?

The best method of employing labor is the apprenticeship system, securing as far as possible young men, making them serve in the various departments, say six months in each, and increasing their salary as they become more proficient. These young men before starting should have at least entered a high school and should be of good habits. F. G. PROUTT.

Y 15. What set of written or printed rules and regulations are in use by electric-light companies, covering the government of employees, also as to proper precautions to be taken in doing hazardous work, etc.?

W. J. Buckley has gotten out a book containing a number of rules formerly used by Mr. Jas. I. Ayer when in charge of one of the St. Louis lighting companies.

AUGUSTA RY. AND ELEC. CO.

Y 16. Is it advisable to make a rebate to hold the consumer in case of a large bill, when the meter and meter readings are known to be correct?

It is not, unless you are "hunting trouble" or wish to establish a new line of rates applying to a certain class of customers.

RALPH R. LAXTON.

If meter reading and meter are correct, the consumer, if a good one, should pay his bill and say nothing more about it. If a rebate should be allowed, he would very likely come to the conclusion that the company was wrong, but did not want to own up to it. CLAYTON GEIGER.

Usually it is not, as other customers hear of the reductions and then there is no end of trouble. A good strong argument will cover this in almost every case and a manager should always ask himself—Why should you give in when you know you are absolutely correct and the consumer's failure to be convinced is the cause of the trouble? WILLIAM M. LEWIS.

Circumstances should determine this. A satisfied customer is a most valuable asset and it is always best to satisfy your customers, if possible. F. ELLWOOD SMITH.

There are, no doubt, circumstances and conditions that very closely resemble excuses for giving a consumer a rebate if he makes a complaint about the cost after he has consumed a large amount of current. For instance, if the plant is young and you are trying to get a load for your machines and increase business you hate to let go of a customer after once getting him. It is a universal idea among consumers of current that it costs nothing to produce; that the price they are charged for it is a purely arbitrary one, based on nothing but the greed of the stockholders; that after the machines are started it costs no more to supply the whole town than to supply one street. They also have their own ideas about the meters. They think they are for nothing but to make the bill higher, that the reading of them is all guesswork. Suppose a man's bill is, say, $25.00 and when he makes a kick you take off $5.00; it doesn't satisfy him; it simply confirms his suspicions about the cheapness of the stuff, of the worthlessness of the meter, or both: but if you can't get one price you will take another. He feels that by resisting the hold-up he prevented you from gouging him quite as deeply as you wanted to do, but still he wasn't able to protect himself against being plundered a little; but he resolves that he will be next time, and he tells his neighbors and friends, and you find that you have increased your trouble instead of decreasing it. I have had people insinuate all these things at one time or another. Would it not be better, by heart-to-heart talks, by liberal investments in printer's ink, and by firmly but courteously refusing to give any unusual discounts, to educate the public to know that the same principles apply to the electrical business that apply to any other mercantile business; that the outfit and supplies cost big money; that the cost of coal and water bears a direct relation to the amount of current furnished, and that the price charged is based entirely on the cost of running, interest on first cost, and such items? The experience I have had leads me to believe that it would and that the person is better satisfied and gets a higher opinion of you and of the business if you firmly refuse to take anything off his bill, even if he cuts out. The chances are that he will continue to use his lights and use them more economically, and you will have a friend.

East River Elec. Co.
Collector.

Never; for when you do, you have simply acknowledged that your meter is subject to errors and the consumer never forgets it and also takes a delight in telling his friends; whereas if you hold your own he will come across and if he doesn't he will never tell how it happened. FRED M. LEGE, JR.

No; adhere to your meter system as your sole standard of rendering bills. DOUGLASS BURNETT.

If you are positive the bill is correct, get the full amount. Pay for what you get and get paid for what you sell. A rebate on a bill of this kind will bring others of the same nature to you.
E. A. BECHSTEIN.

No; stand by your records absolutely; but every station should have such a scale of rates that the large customer will receive the benefit. Contract should be adhered to.
J. W. CLAPP.

The writer believes that it is advisable to make a rebate to hold a consumer in case of a large bill when the meter and meter readings were known to be correct, although he does not recommend indiscriminate rebates or the offering of rebates unless after a long argument and collateral evidence it has become thoroughly sure that the business will be lost; then, while saving your position, it should be considered merely as a matter of good business policy in keeping your income. JOHN F. GILCHRIST.

Y 17. Is it good practice to insist on deposits from all consumers irrespective of their standing in the community, and if so, should the deposit be in proportion to the installation?

In most places, to demand deposits of persons with established credit would greatly retard the growth of the business.
RALPH R. LAXTON.

Yes. CLAYTON GEIGER.

A deposit should be demanded of every new customer who is a stranger in the town and who can not furnish a security slip signed by some responsible person in the town who is known to the company. The deposit should be in proportion to the installation. WILLIAM M. LEWIS.

The question of requiring deposits from property owners seems to me to be a matter of policy. In my opinion, the best place to draw a line is between property owners and renters.

H. J. GILLE.

Yes; with a few exceptions, and they should be where you feel that the man might be of some value to you, for if you figure up your deposits you will see that the interest on same will help you to a great extent and enable you to put your meters out without charging rent. FRED M. LEGE, JR.

We believe it very doubtful practice to exact deposits from all consumers. We believe this matter should be treated as the matter of credit would be treated in a mercantile establishment. If the consumer has established credit with the company or brings good references, he should be extended the usual credit. If his past record is bad or the business such as to make his account doubtful, he should be asked to make a deposit. In taking a deposit, we believe it should be based on the probable amount of his account rather than on the size of the installation.

FRANK W. FRUEAUFF.

The writer believes that the general asking of deposits is detrimental to the best interests of the business. It will probably always be necessary to ask deposits in some cases; but so far as possible, deposits should be avoided and the deposit account kept down. JOHN F. GILCHRIST.

Get deposits only from customers with doubtful credit, and only as a protection to that customer's account.

DOUGLASS BURNETT.

Good policy would be to require no deposit from property owner or reliable tenant—in the latter case, especially if owner becomes guarantor for company's property; irresponsible consumer should be required to make deposit proportionate to probable consumption. J. W. Clapp.

Y 18. (a) In case an installation has been passed upon by the city inspector as satisfactory, does the electric company have the right to refuse the service if it is satisfied the work has not been done properly? (b) In such case, can the householder, when he is willing to assume the risk, come back on the company for damages for failure to serve?

Under these conditions, the test would be whether or not the installation would endanger the company's lines or apparatus. If it would, the company has the right to protect itself and its patrons. Ralph R. Laxton.

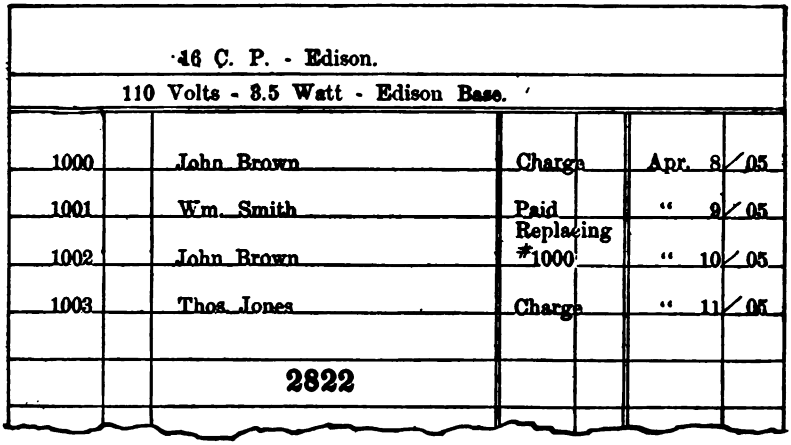
When an installation is favorably passed upon by a properly authorized city inspector, and all other conditions are favorable, it is questionable if a public utility company could maintain a refusal for service, and certainly not if owner and tenant assumed risk for probable damage from improper work. J. W. Clapp.

It is suggested that in such a case the company give its reasons for protest in writing, stating at the same time its willingness to make connection provided the customer will agree in writing to assume all risks. H. T. Hartman.

Y 19. What is the best method of marking incandescent lamps, at the time of issue, so as to guard against unprincipled people buying old lamps as junk and exchanging them for new lamps, where the company gives free renewals?

The following method, which is my own invention, I have found works admirably:

In the first place, I procure from Montgomery Ward & Co. Dennison's consecutive numbers—No. 10. When we get in a shipment of lamps I have the boys unpack them and stick one of the numbers on each lamp; these numbers are stuck over the label the manufacturer puts on the lamp, in order not to have too many labels on the lamp, and thus prevent the consumer from removing either or both of them. The lamps are then put back into the barrel and are ready to be sold. I then have a book in which these same numbers are entered in consecutive order (see sample page enclosed), and whenever a lamp is sold or replaced, an entry covering this lamp is made in the book. The purchaser is warned not to remove our number, as by so doing he forfeits his right to a new lamp in event of its being defective or burning out in an unreasonably short time. Should the lamp be defective, or otherwise bad, and he returns it with our number intact, we refer to the book and can tell at a glance whether or not he was the original purchaser, the date on which it was sold—which, we take it, was the date on which it went into service—and whether it was paid for or charged; last, but not least, whether or not he is entitled to a new one.



16 C. P. - Edison.

110 Volts - 3.5 Watt - Edison Base.

1000		John Brown	Charge		Apr. 8	/05
1001		Wm. Smith	Paid		" 9	/05
1002		John Brown	Replacing #1000		" 10	/05
1003		Thos. Jones	Charge		" 11	/05
		2822				

While we do not give free renewals, this system works equally well in our case where we sell the lamp and make good for defective ones. Then, again, if the manufacturer guarantees the lamp and demands that all defective ones be returned to him, our book will show which we had to make good. While the method has its disadvantages in so far that it is considerable trouble to mark up the lamps, it has its advantages after that.

Jos. Sheridan.

The best method of marking incandescent lamps is to stamp them with an acid stamp, using hydrofluoric acid partially neutralized with ammonium carbonate, the acid being applied to the glass after it has been heated over a gas stove. Lamps that are broken should of course not be renewed, except in cases where they are so few that there is little possibility of any attempt to defraud. H. B. GEAR.

We mark ours with a pencil, as we have not been able to secure a stamp that will fill the bill, and the office boy is about the best stamp I have been able to secure. FRED M. LEGE, JR.

Use hydrofluoric acid and a rubber stamp, making it a rule to exchange new lamps for marked lamps only. M. A. HOGAN.

Several of our customers are marking incandescent lamps, before issue, by etching on the glass globes, with frosting acid applied with a rubber stamp, either the name of the company or some emblem with the words "not to be sold" or "this lamp never sold," the object being to provide some private mark that will enable the owner to swear to the identity of individual lamps found unlawfully in the possession of others.

ELECTRICAL TESTING LABORATORIES.

Make your free renewals conditional on the return of old lamps, and charge about cost for any other lamps; then the other fellow will not have any lamps to sell as junk.

DOUGLASS BURNETT.

The best method of marking incandescent lamps is to have the initials of the company etched on the glass near the base of the lamp. This can be done at the lamp factory. If the initials are etched near the base of the lamp it does not interfere with the light, and effectually identifies the lamp.

THOMAS S. RICHARDSON.

Z

MISCELLANEOUS

Z 1. What per cent of regulation is secured in large plants doing a power and lighting business?

We have a water-power plant of 800-kw capacity, operated by impulse wheels under a head of 950 feet, furnishing current for lighting and a mixed power load, including mines. Our load, on account of mine hoists, will vary instantly in the neighborhood of 200 kilowatts. We use a Lombard governor, Type F, and a T A voltage-regulator. We get a regulation at the power house within two per cent. F. N. AVERILL.

Two per cent would be fair.
AUGUSTA RY. AND ELEC. CO.

Two per cent. C. W. KOINER.

Z 2. What is being done, and how, to utilize the exhaust from gas engine for hot-water heating?

Jacket water may be used in connection with forced circulation of hot-water heating systems.

Exhaust gases may heat water in specially constructed heaters. This water, with jacket water, is of considerable value for heating purposes. The same water is used over and over, saving cost of water when water is bought or pumped.
F. N. JEWETT.

The circulating water from the cylinders of a gas engine is often used as boiler feed in a plant using both steam and gas engines. This hot water is also used to feed the steam boiler used in producer plants to blow steam through the producer.
W. R. COLLIER.

Z 3. Are producer-gas plants complete with engine more economical in units of 75 to 125 horse-power than steam plants of equal size?

Some manufacturers claim as low as two-thirds of a pound of coal per hp-hour, and tests show this to be about accurate. If the full economy were one pound per hp-hour it would be a great deal better than any steam plant could do, even in much larger sizes. W. R. Collier.

Z 4. Given a town of 3000 population wanting an electric-light plant, and having natural gas piped and sold at 15 cents per 1000 feet, with coal delivered at $2.00 per ton, what shall I install in the way of engines, boilers and generators to justify an investment?

Install gas-engine-driven dynamos. G. B. Leland.

It is highly improbable that a plant in a town of 3000 population would justify the investment required, even if there were no competition whatever. With natural gas competition at 15 cents per 1000, its finish is in plain sight. H. T. Hartman.

Use natural gas. R. N. Kimball.

Z 5. Under equal conditions of total current generated in 24 hours, management, cost of coal and supplies, type of engines, boilers and auxiliary machinery, can a central station doing an exclusive business in alternating-current commercial and street lighting, deliver a kilowatt-hour at switchboard at the same cost that would prevail in a direct-current street railway station?

All other things being equal, except that the dynamos in one station are alternators and the dynamos in another station are direct-current generators, the cost of a kilowatt-hour at the switchboard ought to be the same. It should be remembered, however, that the conditions are ordinarily not equal when a comparison is made between an electric-lighting plant and a street-railway plant, because the load factor will differ even though the remaining features may be made equal for the two stations.

Dugald C. Jackson.

Under the conditions mentioned the lighting station would probably be under the disadvantage of operating the entire twenty-four hours to produce a given amount of current, while the railway company generates the same amount in eighteen hours or less, so its load factor would be considerably better than that of the lighting company unless the number of cars operated were small, in which case it might be much worse. Ordinarily, a lighting company is at a decided disadvantage in this respect, much worse than the comparative load factors would indicate, and the probabilities are against its being able to operate as cheaply on that account, while it has had an even more serious disadvantage in the matter of fixed charges. H. T. HARTMAN.

It depends on load factor. R. N. KIMBALL.

Z 6. A town of 10,000 inhabitants has a waterfall 10 miles distant, capable of supplying 500 brake horse-power on water-wheel shaft 9 months of the year, but power may be diminished to 200 horse-power during part of the other three months; there is a possible market in the town for 1000 kilowatts for traction, light and factory motors. Assuming that an auxiliary steam plant be located in the town, what kind of voltage and current should be adopted?

Adopt the 60-cycle, 3-phase, 4-wire, 4000-volt system in the city, but transmit the energy from the water-power plant by 3-phase, 3-wire, 60-cycle at 10,000 volts. C. A. KELLER.

Three-phase, 60-cycle current, generated at your water-power plant at 6600 volts without transformers, stepped down in town to 2200 for distribution.

Steam plant, 2200 volts, same as above, arranged to synchronize with your water-power plant. F. N. AVERILL.

Z 7. Can a water-power plant of 400 to 500 horse-power, costing $150,000, successfully compete with a steam station of half the cost with coal (lignite at $1.00 per ton)?

I think not. With so high a first cost you would have to keep your plant at full load all the time. We use lignite at times of low water and can run as low as nine and one-third pounds per kilowatt-hour. L. E. WATSON.

The probabilities are that, taking fixed charges into account, the steam station would be the more economical of the two under the conditions mentioned. Whether it could "successfully compete" would depend more on the amount of business available and on the comparative efficiencies of management than on the switchboard cost. The fact that the two plants are so small would indicate conditions under which neither plant could make operating expenses under active competition. H. T. HARTMAN.

Z 8. Is there a municipal electric-light plant in this country operated economically and successfully? If so, state where and give your authority.

The trouble with most municipal plants is an excess of economy. Too many charges belonging to the lighting plant are paid by other departments.

See municipal reports, city of Bangor, Maine.

J. M. CARTWRIGHT.

Z 9. (a) What percentage of the normal direct-current voltage is sufficient to bring a rotary converter of standard design up to rated speed; (b) what percentage of the normal alternating-current pressure is sufficient to bring a synchronous machine of standard design up to rated speed?

About 33 per cent. B. JAMIESON.

Approximately half voltage is sufficient to bring a synchronous motor generator up to speed from the alternating-current side. THE EDISON ELEC. ILL'G CO. OF BOSTON.

Z 10. Under what conditions do you consider fly-wheel insurance desirable or necessary for central stations?

When engineer in charge does not keep his safety cams in operation on Corliss engines and when using high (rotative) speed engines with no safety devices. With Corliss engines and safety cams properly set and collar out from under governor, no danger need be feared from a runaway engine, either by breaking of main belt or governor belt. CHAS. N. SHAW.

The best insurance is a *good* engine stop.
G. B. LELAND.

Z 11. Is there a possible market for electricity in influencing the growth of vegetation?

One of my customers has used these arc lights for a number of winters over his greenhouses in order to force the growth of his lettuce and has found it to be a good thing.
F. ELLWOOD SMITH.

According to the *Electrical Age* of April, 1905, "electricity, in the growth of plants, has been found useful for forcing and increasing the yield, but it is only recently that a foreign grower is said to have found that by the use of colored globes on arc lights the coloring of the flowers can be altered. A red globe gives a more intense color and a yellow globe a more delicate color."
E. A. TAYLOR.

No. DOUGLASS BURNETT.

Z 12. Has any one found a satisfactory time switch for switching on and off multiple arc or incandescent lamps and signs?

We are using a switch that is made in Hartford, Conn., that is perfectly satisfactory for this purpose. G. B. LELAND.

See answer to question S 28.
THE PHILADELPHIA ELEC. CO.

Answered in question S 28. G. E. PALMER.

There are several. DOUGLASS BURNETT.

Z 13. What kind of wagon or cart is best suited for trouble work, and should it have a gong?

Z 14. (a) What views are now held on the advisability of testing apparatus to a point above working pressure? (b) Does a breakdown test mean a deterioration from that period on?

Breakdown tests of one-minute duration at not to exceed twice the working voltage are very frequently made on high-tension apparatus and cable. Breakdown test does not mean deterioration if design is good and above limits are not exceeded.

P. JUNKERSFELD.

It is generally accepted as necessary to make a test of the disruptive strength of the insulation of the apparatus, for which purpose the pressure must go above the working pressure. The desirable manner of making such tests is discussed in the Standardization Report of the American Institute of Electrical Engineers, which will probably be found in volume 19 of the Transactions of the Institute, beginning at page 1075. Pamphlet copies of this report may be obtained by addressing Mr. Ralph W. Pope, Secretary, 95 Liberty Street, New York City.

DUGALD C. JACKSON.

Z 15. Is it practical and safe to operate a 'phone-ringing circuit as a shunt across a number of lights in series on a direct-current circuit?

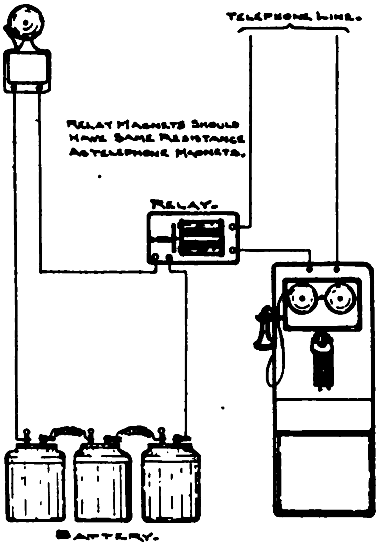
It is practicable, but it is not safe.

DUGALD C. JACKSON.

It has been operated practically, but not generally, on account of the underwriters condemning it.

THE PHILADELPHIA ELEC. CO.

Yes; but a relay and extra battery circuit is better.


TELEPHONE LINE.
RELAY MAGNETS SHOULD HAVE SAME RESISTANCE AS TELEPHONE MAGNETS.
RELAY.
BATTERY.

Fred B. Sharpe.

Z 16. What is a good home-made polish for hot brass and steel?

Z 17. How many candle feet are required for satisfactory service in the following classes of buildings: Churches, libraries, bedrooms, ballrooms, etc.?

Have found the following rule a good one:

For fair light, 1 16-cp lamp for 550 cubic feet
" good " 1 " " " 500 " "
" bright" 1 " " " 450 to 475 cubic feet

A great deal depends upon the color of interior, a blue interior being the most difficult to light. A. Peters.

For rooms requiring a high degree of illumination, such as drafting rooms, try 2.5 watts per square foot; for rooms in which reading is done and goods are well displayed, try two watts; for outdoor service, such as railroad yards, try one watt.

Douglass Burnett.

Churches—A minimum of one candle-foot on a plane four feet above the level of the floor, where an ordinary hymn book is held, will give satisfactory illumination. Great care should be exercised, however, that the lights are so placed that the shadow of the person's body will not interfere so as to cut down this illumination. In other words, the concentration of light in a large chandelier is strictly to be avoided.

Libraries—A general illumination of not less than one candle-foot, and on top of this should be superimposed for desk lighting an illumination of not exceeding three candle-feet. Too much illumination on the desks is strictly to be avoided, as same is tiresome to the eye and is a hindrance rather than an aid.

Bedrooms—The illumination of the bedroom can fall as low as one-half candle-foot at points and still be satisfactory. In places, however, such as over the dresser, tables, *et cætera,* the illumination should be raised to two candle-feet.

Ballrooms—An illumination of not less than two candle-feet should be allowed for. The illumination should be uniform and should come from a number of different outlets, not being centered in one large center light.

In all of the above cases the effect of the interior decoration, walls, *et cætera,* should be strictly borne in mind, and the candle-feet should be reckoned after making due allowance for the reflections. V. R. LANSINGH.

Z 18. What should be the ratio of the rated generating capacity to the maximum load in central-station systems?

Over 100 per cent; the excess to be determined by the number and capacity of available reserve units.

DOUGLASS BURNETT.

A central station should have sufficient generating capacity so that it would still be able to supply its maximum demand in case of the breakdown of any piece of apparatus in the station. Three or four units, all of the same size, would make a convenient arrangement in building a new station. The load increases so rapidly, however, that an equipment that seemed ample five years ago would now form only a comparatively small part of the outfit required to meet present conditions. H. T. HARTMAN.

Z 19. How can rotary converters used on light and power systems be started from the alternating-current side with the least amount of effect upon the voltage of the line?

By the use of a starting motor of proper size, having variable resistance in armature circuit. Ralph R. Laxton.

If the rotary is to be started directly from the alternating-current side, then the use of a starting motor having economical starting conditions would be the most suitable means for starting and bringing the rotary up to speed. The direct application of the alternating current to the rotary converter itself will require probably from three to five times as much current from the line as in the case of the starting motor. In case a small motor-generator can be installed for furnishing direct current for starting, then the effect on the alternating-current system would probably be a minimum, as the motor-generator set can be started light with a very small current, and the rotary can afterward be started by direct current from the starting set with almost no effect on the alternating-current system.

There is another method of starting which has lately been put out in a small number of cases. In this method the rotary is started by means of a single-phase series type motor with a commutator. Such a motor, having series characteristics, can develop a comparatively high torque at start with considerably less current than required by an induction motor. With this arrangement a rotary can be started with a pull on the alternating-current system equal to about eight or ten per cent of the rated capacity of the rotary.

The Westinghouse Elec. and Mfg. Co.

A separate motor for starting will be the best means for the alternating-current side to accomplish the result specified, but the rotary is possible of very much easier starting conditions from the direct-current side.

The Edison Elec. Ill'g Co. of Boston.

The simplest arrangement is to have taps on the secondaries of the transformers giving one-half potential, which will allow the rotary to start with about one and a half times the full-load current.

If a compensator is used it is generally installed in the primary circuits of the step-down transformers. In either case, a double-throw starting switch is employed, which when thrown one way connects the armature of the rotary to the lower starting voltage.

E. F. Legge.

The best practice for starting rotary converters with minimum line disturbance is generally conceded to be by means of a small induction motor, belted, geared or direct connected to the shaft of the rotary. This motor should have a slightly higher speed than that of the rotary converter when in synchronism.

M. Carrington.

Z 20. An Edison 3-wire system is fed by rotary converters or motor generators through transmission lines from a high-tension polyphase generating station. What is the best and quickest method of starting up after a partial or total shut-down occurring at the time of the peak?

This depends on the nature and extent of the shut-down. If the shut-down is complete and there are no storage batteries on the system, it will be necessary to start from the alternating-current end. This can probably best be done by closing the high-tension switches at both the generating and sub-station end and then starting up the generator, letting the sub-station apparatus come up to speed with the generator. If the shut-down is only partial, or if there are batteries that keep the system alive, it will probably save time to start machines from the direct-current end. As a rule, a rotary or motor-generator supplying direct current can be run from the direct-current end and brought up to synchronous speed when the 'bus voltage is as low as 25 to 30 per cent of the normal amount.

The limiting feature in connection with starting up from a low direct-current voltage is generally the voltage required to operate auxiliary apparatus, such as synchronizers and remote-controlled oil switches. Tests should be made to determine the lowest voltage at which the auxiliary apparatus used in connection with rotaries or motor-generators will operate. It is also desirable to have at least one rotary or motor-generator arranged for starting from the alternating-current end at full line pressure, since conditions are likely to arise when one substation will be shut down and the system supplied by it practically dead, while on account of other load on the generating station it is not possible to start a generator at a low pressure for the purpose of getting in service the one substation that is disabled. W. G. CARLTON.

Z 21. What inducements are offered by electric-lighting companies in the large cities of the United States to owners of dwelling-house properties in the built-up sections of the city, to encourage and induce them to wire their properties?

The best inducement that can be offered to owners of buildings to wire them for electric service is for the company to do this wiring on the installment plan and sublet it to local concerns, paying the contractors cash when work is completed and taking pay from the customer in installments. . F. G. PROUTT.

Would recommend persistent personal soliciting.
D. O'CONNELL.

By seeing that competitive bids from wiring contractors are submitted, that the prices are reasonable, and that the system of wiring proposed is a proper one. We have succeeded within the last year or so in having all new three-story houses wired, and have broken the ice on two-story houses. These latter are erected in rows of from 10 to 150 here, as there is no tenement district. We started at $25 per house, and are now down to $19. We have an understanding with the wiring contractors that where there are bay windows or outside rooms, a 'bus line shall be established at our expense, and the wiring lead shall be brought out for convenient connection to the 'bus line. We then only have one transformer for the row of houses, connected by a single set of secondaries. We make no minimum charge, and furnish incandescent lamp renewals free. DOUGLASS BURNETT.

Z 22. What inducements do electric-lighting companies in large cities in the United States offer to architects, contractors and builders, to encourage them to include electric-light wiring

in their plans and specifications for all new dwelling-house operations?

We assist the architects, contractors and builders in every possible way by advising as to the best arrangement and number of lamps, and if necessary getting specifications and bids on wiring. We make frequent calls at architects' offices, and have them on our mailing list for all printed matter issued. We also canvass the owners and occupants of the buildings.

DOUGLASS BURNETT.

We offer to draw up the plans and specification for the wiring free of charge is all. FRED M. LEGE, JR.

Would recommend man on the spot. D. O'CONNELL.

Z 23. What arrangements are made by electric-light companies doing contracting work, or supervising the work of electrical contractors, to comply with the underwriters' rule requiring switch and fuse-box at point of entrance of wires to building to be so placed as to cut off current from all devices, including meter, and yet protect the meter from short-circuit on the interior wiring? Are two sets of fuses used, one ahead of and one behind the meter? If so, how is bridging the meter prevented?

The general arrangement of fuse blocks and switches at entrance is something like this in small buildings; large ones are more elaborate: Service is brought to a main line cut-out, then to a double-pole switch, then to meter loop, then to branch cut-outs. Cut-outs all enclosed in fireproof cabinets where possible.

H. N. CRANDALL.

If the service switch is provided with a fuse on the service end of the switch that is in proportion to the capacity of the line and the meter, this fuse affords ample protection to the meter from any short-circuit on the interior wiring. There is no necessity for using two sets of fuses, one on each side of the meter.

H. B. GEAR.

The best way, in my opinion, to prevent meter bridging is to put in a sealed service cabinet, sealed in a similar manner to meters.
H. J. GILLE.

Do not think the rule is intended to exact protection for meter from interior wiring beyond the distributing cabinet.
D. O'CONNELL.

We enforce the code to the letter and require a standard meter loop behind the main switch and cut-out box, also brackets on the house so service wires may be pulled up tight.
FRED M. LEGE, JR.

Z 24. Would it not be more advantageous if the National Board of Fire Underwriters would establish standard centres for the length of enclosed fuses and require all manufacturers to adhere to it?

Yes. FRED B. SHARPE.

Yes; a standard terminal should also be agreed upon.
CHARLESTON CONSOL. RY., GAS AND ELEC. CO.

The National Board of Fire Underwriters has already established standard dimensions for enclosed fuses. Fuses made up in accordance with these requirements are known as the National Electrical Code fuses and are made by all standard manufacturers.
GEORGE H. JONES.

Yes. This would not only assist the jobbers and manufacturers, but it would assist the central-station repair and trouble man.
A. BALSLEY.

Z 25. An electrical plant operating 3-phase system has its city divided into districts, each supplied from one of its phases and a neutral wire. With this system would it be preferable to use single-phase or 3-phase induction motors, the 3-phase motors necessitating expense of running the additional phases?

I would advise three-phase motors unless they are very small. Single-phase motors unbalance the system. H. N. CRANDALL.

If the power load can be fairly well divided among the three phases, the single-phase installations have some advantages, particularly as regards transformers and meters. Single-phase motors are, however, rather less reliable and more complicated than three-phase, and, at the same time, more expensive. Just now, the weight of authority would probably be found in favor of three-phase motors in sizes above five horse-power.

RALPH R. LAXTON.

It is certainly preferable to run single-phase motors up to at least 10 horse-power, even in a three-phase system, both on account of the smaller cost of transformers and the smaller maintenance expense. H. J. MEYER.

It would be preferable to use single-phase motors on account of the saving in transformer cost and losses, and simplified meter and other connections. A. R. MACKINNON.

The use of single-phase induction motors in sizes up to 15 horse-power should prove entirely satisfactory. The three-phase motors not only call for an additional wire, but also for one or two additional transformers, thus calling for additional fixed charges to the station. A. BALSLEY.

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D 3 In a hand-fired plant, with limited boiler capacity, which is considered the cheapest fuel, bituminous screenings, run of mine or lump?—p. 41.

D 4 What experience have you had with use of slack coal in connection with automatic stokers, and what grade have you found most satisfactory, very fine slack, mixture of slack and pea, or slack, pea and nut, or only pea or nut sizes?—p. 42.

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F 5 Which is the better practice in a station of 600 horse-power—to use forced draft and economizers or to have a good chimney?—p. 81.

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H 7 (a) What is being done with regard to running gas engines direct-connected or direct-belted to another shaft which is already driven by steam engines? (b) Will the gas engine operate satisfactorily connected with steam-driven machinery? —p. 107.

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H 19 What has been found to give best results in practice with regard to leakage, friction and wear in piston-valve engines—plain piston valves or adjustable?—p. 115.

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H 27 Is not the small belted unit for stations up to 400-hp with short-load peak and 30 to 100-kw all-night load more economical than larger, 200 to 400-kw units, direct-connected, where fuel is only $1.00 per ton? Does it not make a more flexible station to operate, with less liability to disablement?—p. 122.

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H 29 What changes are necessary in a Corliss engine with double eccentric to get more compression in the crank end of cylinder when the reach rod from wrist plate to exhaust valve has been adjusted all that it will allow?—p. 124.

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I 6 With a load factor of about 40 per cent, with a jet condenser giving an average of 26 inches vacuum, would a 400-kw steam turbine set operate as cheaply, fixed expense included, as a compound Corliss non-condensing engine?—p. 127.

I 7 Is the steam turbine advisable for small stations? State minimum size of units.—p. 127.

I 8 Are turbines of small capacity as efficient under variable loads, such as exist in a small railway power-house, as small steam engines of the same capacity?—p. 127.

I 9 Will some of the companies who are operating steam turbines give the pounds of coal (giving B. t. u. per pound) necessary to produce a kilowatt-hour at the switchboard?—p. 127.

I 10 Does a steam turbine require more or less pounds of steam per kilowatt-hour output at switchboard than same size unit Corliss compound-condensing engine, both running at 175 pounds steam pressure, 150 degrees Fahrenheit superheat, and 27-inch vacuum?—p. 128.

I 11 What is the monetary and sustained overload capacity of the steam turbine compared with that of the Corliss engine?—p. 128.

I 12 Is not the inertia governor better adapted for steam turbines than the purely centrifugal governor?—p. 129.

I 13 How long will steel buckets in steam turbines withstand the effects of wet steam, pressure 140 pounds, before they wear sufficiently to decrease the steam economy by 10 per cent?—p. 129.

I 14 (a) What is the wear on turbine vanes, and how does this change their clearance, and (b) what type of turbine is least affected by change in clearance?—p. 129.

I 15 What difficulties have developed in the practical operation of steam turbines?—p. 129.

J

District Heating

J 1 Does steam reduced from 100 pounds to 1 pound through a reducing valve contain more heat than steam from exhaust at one pound, or than steam generated at one pound; if not, what becomes of the energy that is apparently lost?—p. 130.

J 2 Does district heating justify the expenditure in towns where heat does not have to be distributed further than 1000 feet from the central station. where the heating amounts to between 50,000 and 100,000 square feet?—p. 132.

J 3 Does district heating pay if you go beyond the amount of exhaust steam furnished by your engines; if so, at what price? (Give price and heat value of coal.)—p. 133.

J 4 Will it be a proper thing to put a centrifugal pump on the return main of a hot-water main that has a back pressure of 10

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pounds one mile away from the station? There is a sag of 6 feet in our main at that point; the mains are of same size, supply and return. Most of this distance is down grade. —p. 134.

J 5 In operating district steam-heating plant on Paul vacuum system we find it impossible to maintain vacuum; what is the most probable reason for same?—p. 134.

J 6 Under what conditions does district heating from a central station pay?—p. 135.

J 7 (a) Has any one tried using a double-expansion joint on the steam mains instead of the variators? If so, with what success? (b) Have they been able to insulate the mains from the frost as well with this as where bricked over in the manner in which the variators are covered?—p. 136.

J 8 Will it be good investment to install heating system in a town of 5000, laying 2000 feet of pipe, no day load, but station running 16 hours per day, with peak from 150 to 200 kilowatts, slack at 50 cents in bin, domestic coal at $2.50? Town already has a number of steam-heating plants in business houses.—p. 136.

J 9 Is there a meter for steam heating that gives reasonably accurate results and reliable service?—p. 137.

J 10 What is the economical limit of distance for the transmission of heat by steam or hot water in district heating? What "head" in pounds per square inch is required per 1000 feet of line for the transmission of heat by steam at the pressure employed? —p. 138.

J 11 To what extent is it economical to supply exhaust steam for heating?—p. 139.

J 12 (a) Is it not time to place "district heating" in its proper place as a business by itself? (b) Can it be made to pay its own way? (c) What is the ideal method of making charges for this ideal heat? (d) Provided regulation at plant is good, has any efficiency been gained by use of regulators on houses for hot-water heating from actual reliable tests?—p. 140.

J 13 Which is the better plan where a new lighting and power company is establishing a station with an expected annual load factor of 30 per cent, 24 hours' lighting service—to operate the heating system with live steam and engines of the highest possible efficiency for generating current, or to use engines of lower efficiency, utilizing exhaust for heating?—p. 142.

J 14 Why is better circulation secured with exhaust steam at any pressure than with live steam at the same pressure supplied through a reducing valve?—p. 143.

J 15 How can a readiness-to-serve charge be incorporated in a meter rate for heating, and what should such a charge cover?—p. 143.

J 16 What are the best material and method for covering steam pipes in streets to obtain maximum efficiency in transmission of heat units to consumers?—p. 144.

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J 17 Has any practical method been devised for measuring quantity of live steam delivered to district-heating mains when exhaust is insufficient?—p. 144.

J 18 How much more will central-station heating customers pay per annum for central-station heat than the cost of running their own heating apparatus?—p. 145.

J 19 How many, if any, steam traps should be placed on a steam-heating main of 4000 feet length, with six right-angled bends in full length?—p. 145.

J 20 In laying street mains for steam heating with exhaust steam, which will cause the least trouble and have the longest life—variators or brass-lined slip joints?—p. 146.

K

GENERATORS AND EXCITERS

K 1 Would the vibration be objectionable in a direct-current generator direct-connected through a pair of bevel mortise gears to a vertical water-wheel?—p. 146.

K 2 What is better than cylinder oil and vaseline for lubricating collector rings?—p. 146.

K 3 (a) Should a small central station install polyphase generators, and (b) how can the difficulty of balancing the circuits be overcome?—p. 147.

K 4 What advantages or disadvantages has an induction-type generator over a revolving-field type on inductive and non-inductive load?—p. 151.

K 5 Under what conditions, if any, have you found automatic circuit-opening devices advisable on generators or exciters?—p. 152.

K 6 What are the comparative advantages and disadvantages of self and separate excitation for large direct-current generators?—p. 153.

K 7 Is an induction motor-driven exciter set ever advisable for alternating-current generators?—p. 154.

K 8 In large power stations where steam and electric-driven exciters are now both provided, which is it more economical to use after starting up?—p. 155.

K 9 Is it not a good policy to install an exciter of double the capacity required and use an armature of double the voltage and operate at half speed?—p. 157.

K 10 In connection with an underground Edison 3-wire system operated from a substation, which of the three methods of conversion from 60-cycle alternating current to direct current—namely, rotary converters, induction motor-generator sets, or synchronous motor-generator sets—will give best results if a heavy short should develop on the 3-wire direct-current system?—p. 158.

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K 11 (a) What is the probable difference in cost and efficiency at one-half, three-quarters and full load between using static transformers and a rotary converter and using a synchronous motor-generator set, the motor taking full alternating-current voltage, say 6600 volts? (b) What is probable difference in case of an induction motor-generator set?—p. 161.

K 12 What are the points in favor of use of air compressors for central-station use for cleaning dynamos, etc.?—p. 162.

K 13 (a) What is considered as the working life on a 125-volt, 300-kilowatt, moderate-speed direct-current commutator? (b) What is annual expense for carbon brushes?—p. 164.

K 14 Is it practicable to overload an incoming generator on a water rheostat and thus lower its frequency, in order that it may be synchronized with a generator that is overloaded and running below speed?—p. 165.

K 15 In the operation of alternators in parallel, driven by reciprocating engines and turbines, is there any tendency shown for the turbine sets to take all or nearly all the fluctuations of the station load?—p. 165.

K 16 In the operation of alternators in parallel, driven by reciprocating engines and turbines, what tendency, if any, is shown for a heavy cross-current at time of sudden overload or short-circuit? —p. 167.

K 17 (a) What is found to be the best method of grounding the star point of large (1000-kw or over) generators—grounding through one rheostat common to all machines, each generator through separate rheostat, or otherwise, and (b) what sort of rheostat or connection to ground is best?—p. 167.

K 18 In motor-generator sets consisting of a polyphase motor and direct-current or alternating-current generator, what advantages have induction over synchronous motors?—p. 168.

K 19 Is it practical to use a Hopkinson, Kapp or other similar test on two 6-phase rotaries in the substation, connected to run normally in multiple from the same 'bus-bars, which are supplied by a 3-phase line, a separate engine being available at the generating station? Assuming first that their shafts can not be interconnected, and second, that they can be interconnected. Give description of method or connections.—p. 170.

L

STORAGE BATTERIES AND BOOSTERS

L 1 What is the value of storage batteries floating on exciter circuits? —p. 171.

L 2 Does it pay a small plant to install batteries? What is the depreciation of storage-battery installations?—p. 173.

L 3 Is it not more profitable for medium-sized plants to increase their station capacity than to put in storage batteries?—p. 174.

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L 4 What would be the original cost, cost of operation and cost of maintenance of a set of accumulators to operate 200 16-candle-power, 110-volt lamps three hours?—p. 175.

L 5 What is the ampere capacity of a storage battery at high rates of discharge, say the 5, 10, 15, 20, 30 and 45-minute rate, in terms of the one-hour rate?—p. 175.

L 6 Can a storage battery be successfully connected to the Edison 3-wire system so that it will automatically charge or discharge as the rise or fall of the current strength may demand, without the care of an operator at the substation?—p. 175.

L 7 Is there a formula, or what determines the ratio of storage-battery capacity to total connected load in large cities?—p. 176.

L 8 (a) What is the actual efficiency (energy) obtained from a storage battery, (b) the efficiency (quantity)?—p. 177.

L 9 Is it advisable to use recording voltmeters and ammeters in connection with the operation of storage batteries? If so, to what extent and for what purpose?—p. 177.

L 10 Has a simple method been found for taking the acid fumes out of the air discharged from storage-battery rooms?—p. 178.

L 11 What results have been obtained from use of board separators in storage batteries?—p. 179.

L 12 What methods are used in removing sediment from storage cells, and which is considered most satisfactory?—p. 179.

L 13 When a leak has once developed in lead-lined oak tanks, saturating the wood with electrolyte, and the leak in the lining been repaired, cells mounted on porcelain feet four inches high, will electrolytic action set in with a likelihood of pitting the lining from the bottom upward and rotting the wooden tank? If not, what is responsible for such action? If so, is there any known remedy other than the replacing of tanks, once they leak? It has taken place in a number of cells with entirely new linings but old tanks.—p. 180.

L 14 What paint or compound have you found most satisfactory for painting the outside of storage-battery tanks to protect them from the action of the acid fumes?—p. 181.

L 15 What are the relative merits of the booster and the end-cell switch methods for battery regulation on light and power systems? Is any lighting company using the booster method on a 3-wire Edison system?—p. 181.

L 16 In what order of importance do central-station companies regard the functions of their storage batteries? (a) Regulation. (b) Taking of the peak load. (c) Emergency reserve.—p. 182.

L 17 What should be the ratio of the battery capacity at the one and one-quarter hour rate to the total generating capacity in central-station systems?—p. 182.

L 18 When sulphate forms on plates, what is the best method for removing it?—p. 183.

M

SWITCHBOARDS, INSTRUMENTS AND STATION WIRING

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M 1 What one particular feature in your switchboards, instruments and station wiring has been the greatest danger to reliability (a) to service from your station? (b) From your substation? (c) What remedy did you apply?—p. 184.

M 2 What are the principal troubles likely to occur with remote-controlled oil switches for pressures above 5000 volts? To what causes have failures of oil switches to open circuits been attributed?—p. 185.

M 3 What success has been attained with the "horn-type" high-tension open-air switch? Does not above switch throw considerable strain upon apparatus?—p. 185.

M 4 Are soapstone structures necessary in 'bus-bar installations of high voltage and large power?—p. 186.

M 5 Should switchboards of large stations be made self-explanatory; i. e., have the connections diagrammatically indicated on the face?—p. 186.

M 6 Is it not the best policy to have your switchboard very simple—to eliminate fuses and circuit-breakers?—p. 187.

M 7 Is it standard practice to place fuses in the primary connections of pressure transformers supplying switchboard voltmeters, wattmeters, etc.?—p. 188.

M 8 Is it safe to operate a skeleton wooden board with a potential of 2000 volts, having the wires well insulated and using oil switches?—p. 190.

M 9 Is there any satisfactory and economical method of feeder regulation for direct current?—p. 191.

M 10 How do you obtain satisfactory regulation on alternating-current 60-cycle distribution system? Do you use hand or automatic regulators?—p. 192.

M 11 Is the feeder-pressure regulator a desirable auxiliary for the small central station?—p. 194.

M 12 What is the advantage of taking hourly readings on all feeder circuits? Does their value justify the use of an extra man or helper for this purpose?—p. 195.

M 13 How often is it advisable to test switchboard instruments?—p. 197.

M 14 What is the most accurate way to check up alternating-current switchboard instruments when they are used in connection with current and potential transformers?—p. 199.

M 15 Which is the best transformer instrument for use in standardizing alternating-current ammeters—a Kelvin balance, a current dynamometer or a hot-wire ammeter?—p. 202.

M 16 What is the best instrument and method to use in standardizing alternating-current voltmeters?—p. 204.

M 17 What is the best method for determining the work constant of a watt dynamometer?—p. 205.

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M 18 Which will mean more to the station attendant—an ammeter upon the generator panel, on the 3-phase feeder panel or an indicating wattmeter?—p. 206.

M 19 Are separate current transformers necessary for the ammeter and for the time-limit relay on alternating-current feeders, or can both instruments be operated satisfactorily from one transformer?—p. 208.

M 20 (a) What is considered the best design for ground plates? (b) What is regarded as the best practice in locating same, and their connection to the different generators, transformers and instruments in stations or substations? (c) Should all this apparatus be connected to the same ground 'bus, or should there be an independent ground 'bus for each class of apparatus?—p. 209.

M 21 Should the discharge resistance leads for any generator field switch be insulated for a higher pressure than the field leads?—p. 210.

M 22 Has any form of 3-phase reverse-current relay for use on the substation ends of high-tension feeders in multiple proved satisfactory in service?—p. 210.

M 23 (a) How often is it usual to change the oil in oil switches of 15,000 volts, 100 to 300 amperes capacity, when operated once or twice daily? (b) How can one tell when change should be made?—p. 210.

M 24 In determining the correctness of recording wattmeters, is it necessary to check the ratio of series and shunt transformers from time to time when such apparatus is used on wattmeters?—p. 211.

N

BELTS AND SHAFTING

N 1 Are rubber belts for high speed on generators better than leather? Why?—p. 212.

N 2 What per cent of power is wasted in a good belt driving a generator as compared with a direct-connected unit?—p. 213.

N 3 In calculating length of belt, when same must be cut and cemented before putting on, how allow for stretch?—p, 213.

N 4 What is a safe rule for size of shafting for direct-connecting dynamo and water-wheel shaft?—p. 214.

N 5 Which is the most efficient pulley, leather-covered, wood or paper?—p. 215.

O

OIL AND WASTE

O 1 What make of oil is best for lubricating cylinders using superheated steam?—p. 216.

O 2 What fire test should cylinder oil stand for use with 90-pound steam; also 125-pound? Speed 100, cylinder 20 by 42.—p. 216.

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O 3 What are the effects of superheated steam on cylinder lubrication, with 150 pounds pressure; steam superheated to 100 degrees or more?—p. 216.

O 4 Does the most economical cylinder oil have very little or no animal fat?—p. 216.

O 5 Describe some convenient and cheap apparatus for removing oil from used waste and making it suitable for further use. —p. 217.

O 6 What is the length of time one filling of an oiling system can be used where the oil is pumped back into the tank and used over again? Does not the oil gradually wear out?—p. 218.

O 7 If the temperature of oil is 160 degrees Fahrenheit when it comes from the turbine step bearing, is it necessary to cool before using again?—p. 218.

O 8 What is a good lubricant for wooden cog gears meshing with steel pinions?—p. 219.

O 9 If a cylinder oil leaves a sticky, brownish substance on valve seat when the valve has cooled off by exposing to the air, does it show over-compounding, or compounding to give viscosity regardless of lubrication?—p. 219.

P

OVERHEAD LINES

P 1 Has any one used crude oil or tar in the treatment of poles? If so, with what success? State method of application.—p. 220.

P 2 Does creosoting from 7 to 8 feet of the base of cypress poles, where poles are set 5 feet, prolong the life of same long enough to justify the expense of creosoting?—p. 220.

P 3 In building a 2200-volt single-phase transmission line how should the transposing poles be constructed?—p. 222.

P 4 What is a good method of dead-ending heavy primary pole line feeders; something that will answer the purpose of the regular strain insulators?—p. 222.

P 5 With overhead wires, what is the voltage limit to be safely handled when lineman is on a wet pole?—p. 223.

P 6 Suggest ways of removing static charge from arc and primary circuits, especially when partly overhead and partly underground.—p. 224.

P 7 (a) What, if any, is gained by using a grounded neutral on an Edison 3-wire, direct-current, 110-220-volt system? (b) What is the best method of grounding same, and how far apart should ground connections be placed?—p. 224.

P 8 What objections are there to grounding the neutral of a 4-wire 3-phase system outside the station and relying upon these ground wires on neutral instead of lightning arresters? This refers to systems operating with neutral grounded in station. —p. 227.

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P 9 (a) Is it good policy to ground lightning arresters to street-railway track, provided the tracks and water mains are bonded together at the power-house? (b) If this ground is not considered sufficient at a distance of two miles from the power-house, would there be any danger to the track or cars?—p. 228.

P 10 Is there any successful method of protecting high-tension transmission lines from lightning? Where is it used?—p. 229.

P 11 Describe a good method of placing lightning arresters on a junction pole of a transmission line where the aerial line joins underground cable.—p. 229.

P 12 What is the smallest size weatherproof copper wire mechanically safe for overhead city line?—p. 230.

P 13 What factors should determine the size and numbers of feeders to be installed?—p. 233.

P 14 What is the advisability of dividing overhead line into sections by switches located in various districts?—p. 234.

P 15 Can not our overhead lines be made more reliable by increasing the spacing and sags where space is available?—p. 236.

P 16 What is the best distance apart for wires on 2200-volt circuits where circuits are in use 24 hours per day?—p. 237.

P 17 Would it be advisable to tie high-potential wires with iron tie wires?—p. 238.

P 18 Are best results obtained by fitting of pins in cross-arms in store-room, where painting shank of pin with white lead and fastening pin with a galvanized nail is easily done, or by leaving this fitting to linemen and not leading shank of pin?—p. 240.

P 19 (a) What is best to do with overhead high-tension alternating-current lines where line passes through a good many trees and trimming is objected to? (b) Is there any satisfactory tree insulator in use?—p. 242.

P 20 Are there any insulator troubles on (a) alternating-current lighting circuits of 2200 to 3000 volts; (b) on series alternating-current lighting circuits up to 7200 or 8000 volts?—p. 244.

P 21 Is it practicable to run a telephone line on the same poles with 2300-volt lighting circuits within two feet of the other wires? If so, how often should such a line be transposed? How often when on the same poles with a 500-volt direct-current circuit? —p. 244.

P 22 Is it possible for telegraph wires to be affected in any way by direct-current mains (3-wire) at a distance of two feet? —p. 246.

P 23 How shall we get rid of the effects of induction on our telephone wires on cross-arms two feet under our 11,000-volt 13-mile transmission wires?—p. 246.

P 24 When two lighting companies are required to make joint use of certain poles, each having 2200-volt primary alternating-current lines and 220-volt secondary lines, which of the following arrangements of the wires is the safer? (a) A zone at the

top of the pole for the high-pressure wires of one company, followed immediately beneath by the zone for the high-pressure wires of the second company, the low-pressure wires of the first company being then placed in a zone beneath the high-pressure of the second company, followed in their turn by the low-pressure wires of the second company; or (b) high-pressure wires of first company at top of pole, followed beneath by zone for low-pressure wires of this company, then by zone for high-pressure wires of second company, and finally by the low-pressure wires of second company.—p. 248.

P 25 Referring to Class "B," rules of National Board of Fire Underwriters, Section C, stating that service wires must be at least seven feet above highest point of flat roofs, should this apply to an Edison three-wire system with 500 volts between outside wires? Should not service wires at this low voltage be exempt from this ruling and a lesser amount than seven feet be approved?—p. 250.

P 26 (a) What provisions are made against high-tension wires falling across telephone, telegraph or other foreign wires at crossings? (b) What is the approximate cost of protecting one crossing? —p. 250.

P 27 Where high-voltage lighting wires (2500 to 6000 volts), telephone wires and municipal fire-alarm wires are all on one set of poles, should the telephone and fire-alarm wires be placed above or below lighting lines? Give reasons for opinion. —p. 251.

P 28 (a) What form of device for disconnecting overhead wires from underground cables for the purpose of testing has been found safe and easy to handle? (b) Do you consider it advisable to place such device on cable poles?—p. 255.

P 29 What forms of potheads or joints have been found satisfactory for connection between overhead and underground lines for voltages ranging from 1000 to 5000?—p. 257.

P 30 What insulation resistance should be required in testing high-tension lines subject to a voltage of 2000, 4000, 7000 or 14,000? Should a breakdown test be made on such lines? And what voltages should be used in the test?—p. 258.

P 31 How should record of connected load on feeders, mains, transformers and secondaries be kept so that it will be flexible, accurate and easy to refer to? Illustrate by sample of cards used. —p. 258.

P 32 What is the best method of keeping record of location, size, etc., of overhead lines? Describe a desirable system of symbols for poles and lines.—p. 263.

P 33 What method of taking and recording data constitutes the most accurate means of determining the resistance losses in both primary and secondary systems of distribution where the circuits are always alive?—p. 264.

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P 34 Have you any system of regularly inspecting pole lines? If so, what records are kept showing the condition of the lines at time of inspection?—p. 264.

P 35 What should overhead repairs cost per annum per kilowatt-hour sold?—p. 268.

P 36 (a) What is the average life of yellow-pine cross-arms? (b) Cypress cross-arms? (c) White-pine cross-arms?—p. 268.

P 37 Is it good practice to carry more than one high-tension, 3-phase circuit on a single pole line?—p. 269.

P 38 In running a transmission line through the country is there sufficient gain in using insulated wire to warrant the extra cost?—p. 271.

P 39 Where the underground and overhead on a 3-phase 15,000-volt transmission line meet, what would be the limit of distance away from the riser that one might install arresters or static dissipators with good effect? Would there be any objection to one arrester for one phase on each of three consecutive poles beyond the riser, the poles being spaced about 100 feet apart?—p. 272.

P 40 Would there be any objections to installing a 220-440-volt overhead distributing system in a small town having so many trees as to prohibit the installation of a 2300-volt system without excessive trimming?—p. 273.

P 41 What is the best combined switch and cut-out to use on aerial lines of 2300 volts, where a tap carrying 15 amperes or more is taken off a main line?—p. 275.

P 42 If a 3-phase grounded system is originally installed, protected from lightning and static by a proper number of arresters on each wire to ground, and later the star point of the generators is grounded, what changes would you make in your arresters?—p. 276.

P 43 On a series incandescent circuit, 5000 volts potential, operated from alternating-current transformer, is it possible to use 2000-volt lightning arresters, one between each wire and the ground?—p. 276.

P 44 In the case of a 3-phase, 60-cycle system supplying motors, is the liability of reversing phases sufficiently great to warrant the use of reverse-phase relays?—p. 277.

Q

UNDERGROUND LINES

Q 1 Is any town of 10,000 population or under using underground lines?—p. 278.

Q 2 How can a central station determine, without going into elaborate details, at what time business will justify putting lines underground?—p. 278.

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Q 3 What are the advantages and disadvantages of paper-insulated and rubber-insulated cables for underground work on 25-cycle, 6600-volt system?—p. 279.

Q 4 Should periodical insulation tests be made on low-tension underground cables? If so, how often should such tests be made and what method of test should be used? Answer same questions relative to high-tension underground cables, also as to overhead lines.—p. 279.

Q 5 What guarantees are demanded of the manufacturer on low-tension cable for underground circuits as to thickness and quality of insulation? As to conductivity? As to thickness and quality of lead? Answer same questions relative to high-tension underground cables.—p. 280.

Q 6 Will some of the companies who have used paper-insulated lead-encased cable on 8000-volt series-arc circuits, including loops up the lamp pole, give their results with same?—p. 281.

Q 7 How does the cost of maintenance of underground lines compare with that of overhead lines?—p. 281.

Q 8 What current-carrying capacity per 1000 circular mils should be allowed in underground feeders?—p. 281.

Q 9 What has been the experience of those operating paper and lead cables under water? Is not the trouble from electrolysis likely to be less and, therefore, the life of the cable longer, than when installed in the ordinary manner?—p. 282.

Q 10 What protection can be given lead covering of underground cables from ground currents?—p. 282.

Q 11 What kind of duct and what kind of insulation is best for underground lines?—p. 283.

Q 12 Do you build conduit with your own men, or do you have it done by contract? Which method do you consider cheaper, and how much?—p. 284.

Q 13 Has any one had experience with tile conduit broken either from water freezing in the ducts or from water absorbed by the tile freezing and cracking same?—p. 284.

Q 14 In laying multiple conduit it is the custom of some companies to use a layer of concrete about three inches in thickness on the bottom and top of conduit, omitting it entirely from the sides. Has any one had experience with conduits so laid being interfered with or broken by men of other companies working around it? Has this method been found to be poor or good economy?—p. 285.

Q 15 How is the leakage of illuminating gas into subway manholes prevented or checked?—p. 285.

Q 16 What is the best method of preventing explosions in manholes from the combination of illuminating gas and air, as well as mixtures of other gases and air?—p. 286.

Q 17 Would it be a desirable adjunct in a transformer manhole to have a ventilating tube run from the bottom of the manhole to the

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open air, or do the pipes carrying the cables provide sufficient circulation of air?—p. 287.

Q 18 Is any feeder cable safe (in large high-tension systems) that will not stand test of double voltage for one minute?—p. 287.

Q 19 What is the reason for the slow introduction of high-tension underground cables, above 13,000 volts?—p. 288.

Q 20 Is the installation of static discharge gaps at both ends of all feeders of a high-tension underground system compatible with safe operation?—p. 288.

Q 21 What method of construction will stop leaking of compound out of paper and lead-covered cables where the end of cable, sweated into the lug, is the lowest point in cable run?—p. 289.

Q 22 What is the cause of bubbles rising in compound of terminal bells in 13,000-volt paper and lead-covered cable transmission lines after same have been in service some time?—p. 289.

Q 23 In an underground 3-wire 110-220-volt direct-current distributing system is a bare stranded cable satisfactory for neutral conductor?—p. 289.

Q 24 What are the lowest figures on record of the annual cost per mile of maintaining underground lines under ordinary conditions?—p. 290.

Q 25 In a moderate-sized system, direct-current, 3-wire, 110-220 volts, about 2000 kilowatts, it is suggested to operate from the station 'bus all feeders running to a distance of 1000 feet or under. Pressure wires determine the rate of rise of 'bus e.m.f. at time of maximum load. Beyond this distance feeders are regulated by motor-driven boosters, latter series wound. How does this check up with modern practice in regulation?—p. 290.

Q 26 Are there any factors, except the resistance, that would cause an observable loss of energy or watts on a 25-cycle, 3-phase transmission line about seven miles long, one-half of which is paper-lead 3-conductor cable and one-half overhead, operating at or under 15,000 volts, and at any power factor, including unity? If so, enumerate same and give formula for their determination. —p. 291.

Q 27 What is the best roof or top (not cover) for manholes containing subway transformers and designed with a view to keeping water from penetrating during spring thaws and heavy rains? —p. 292.

R

TRANSFORMERS

R 1 What has been the average life of lighting transformers?—p. 292.

R 2 Which is the better type of transformer to use, core or shell, for motor service? For lighting service?—p. 293.

R 3 Will a meter-current transformer always maintain its calibration if operated within its rated capacity?—p. 294.

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R 4 What is good practice in the way of inspection of transformer for insulation, leakage and weakness?—p. 294.

R 5 (a) Do you test transformers before placing them on the line and at intervals after they have been in service? (b) How are the records of such tests kept?—p. 294.

R 6 What is the liability of puncturing the insulation between the primary and secondary coils of a current-meter transformer by opening the secondary circuit with a full load on the primary?—p. 296.

R 7 (a) Is it good practice to use transformers of different sizes on an interconnected secondary system, and how should they be fused? (b) How should individual transformers be fused?—p. 296.

R 8 (a) How should the sizes of transformers and secondary mains be determined? (b) What are the limits of economy in substituting large transformers for smaller ones?—p. 299.

R 9 Is it good practice to bank transformers in other than very thickly settled districts; for example, in a district four blocks square, supplying 50 customers?—p. 299.

R 10 (a) How much transformer capacity should be allowed for satisfactory motor service? (b) Should lights and power be served from the same transformer?—p. 300.

R 11 On a three-wire secondary line, 110-220-volts, 3000 feet long, there are two transformers of 30 kilowatts each, located, respectively, 750 feet from either end of the secondary line. Both transformers are supplied with current from the same primary circuit. The maximum load at any one time is very close to 1500 16-candle-power lamps. The proportion of this load located on either side of a point halfway between the two transformers at any time does not exceed 60 per cent of the total load of the entire secondary circuit. Is it better to operate these two transformers in multiple on a continuous secondary circuit, or is it better practice to cut the secondary circuit at a point halfway between the two transformers and operate the secondary as two separate circuits, each one fed by one of the above-mentioned transformers?—p. 302.

R 12 What amount of overloading of transformers on peak load will give the best all-day efficiency? What per cent overload is safe or economical?—p. 304.

R 13 What reasons have led to the recent increase in insulation in transformers? This has been noticed particularly in 10-kilowatt apparatus.—p. 304.

R 14 Do we not pay too much for high efficiency in the transformer, and would not a slight increase in the power loss effect a great saving in first cost and interest?—p. 305.

R 15 Are transformers as efficient when wound for 6000 to 16,000 alternations without changing the primary connections as transformers that are wound for one frequency only?—p. 306.

R 16 In changing over an 1100-volt, single-phase system to 2200 volts, is it practical, safe and economical to take two transformers of the same size and type, connect the primaries of the two in series and parallel the secondaries?—p. 306.

R 17 What causes a transformer to generate static current which affects the secondary circuit to the extent that a person can not handle a chandelier or desk fan without receiving a severe shock?—p. 308.

R 18 (a) Does a transformer oil deteriorate through use, and to what extent? (b) What are the results of immersing insulation in oil for, say, five years?—p. 309.

R 19 (a) Have you been compelled to place constant-current transformers in separate rooms on account of insurance rules? (b) Do you make provision for draining the oil from these transformers in case of fire?—p. 309.

R 20 (a) What is considered the best practice in protecting transformers from lightning—kick coils or lightning arresters, or some of each? (b) What form of ground is efficient and least expensive to install?—p. 310.

R 21 Is grounding the neutral of a three-wire secondary system found to break down many transformers by lightning?—p. 312.

R 22 (a) Is it advisable to ground a transformer where using the two-wire system, and (b) is the efficiency affected if the primary or secondary coils are connected in series?—p. 313.

R 23 Should not the grounded "Y" connections be required in transformation from high-voltage to low-voltage distribution system, as a matter of safety to life as well as property?—p. 314.

R 24 Has the oil-cooled air-transformer any advantages over the air-blast type for transmission line work where lightning disturbances are frequent?—p. 314.

R 25 Would it be feasible to step down from a line pressure of 10,000 volts to a pressure of 2300 volts, transformer to be located on a pole exposed to the weather? This question arises in the case of a small town too far from the generating station to feed economically at 4000 volts, the load of which does not at present warrant the installation of a substation.—p. 315.

R 26 Have any members had trouble with floating-coil constant-current transformers "pumping" or "churning" violently at uneven intervals? If so, under what circumstances or conditions, and what remedy can be applied?—p. 316.

R 27 To what extent is the use of the "Two-transformer Resultant Delta" method of transformation liable to unbalance a 3-phase system on full load where the capacity of transformers is 50 per cent of generating-plant capacity?—p. 317.

R 28 With a cost of 5 per cent in favor of a 3-phase transformer against three single-phase transformers of same total capacity, which is the more desirable and economical to install to furnish current to a 3-phase induction motor? In other words, would one 3-phase, 15-kilowatt transformer be preferable to three single-phase, 5-kilowatt transformers?—p. 318.

S

LAMPS—ARC, INCANDESCENT, ETC.

S 1 In rating alternating-current arc lamps should the apparent or the real watts be the basis?—p. 319.

S 2 What are fair ratings for enclosed-arc lamps that are neither 2000 nor 1200 candle-power?—p. 320.

S 3 What is the cause of hardening of the points of carbons in enclosed alternating-current lamps, with consequent unsatisfactory operation when voltage is correct?—p. 321.

S 4 What results have been obtained by the use of five-sixteenths-inch carbons instead of one-half-inch carbons in direct-current enclosed-arc lamps of three and five amperes; also in 6 and 7.5-ampere alternating-current arc lamps? What is the additional cost per kilowatt-hour for operation and maintenance, and how is the extra expense justified?—p. 322.

S 5 What has been the experience with the new heat-resisting inner globes?—p. 323.

S 6 What results have been obtained with low-current arc lamps, say three amperes and less, in regard to steadiness of light, burning hours, efficiency, and in general?—p. 324.

S 7 What are the principal troubles in connection with the operation of series alternating arc lamps, circuits and regulators?—p. 325.

S 8 What percentage of total hours outage from all causes is considered reasonable on a system of 1000 0.6-ampere direct-current open-arc lamps; also for alternating-current or direct-current enclosed series?—p. 326.

S 9 (a) To what extent are automatic cut-out switches (that is, an automatic device that cuts the lamp out of arc circuit and closes series arc circuits when lamp is lowered) in use? (b) Do they operate successfully on high-voltage circuits?—p. 326.

S 10 What method can be used to obviate open circuits in the connections between series arc lamps and their absolute cut-outs? —p. 327.

S 11 Is it better on three-phase machines to operate arcs on one phase with incandescents and balance by regulator against other two phases, carrying incandescent single phase, or to distribute the arcs on the three phases?—p. 327.

S 12 What should be the cost of trimming street arc lamps (carbons, globes, labor, etc.) for a plant operating 600 street arcs, alternating enclosed? Territory covered, nine square miles.—p. 328.

S 13 How does the free arc lamp trimming and maintenance cost compare with free incandescent lamp renewals and with free Meridian lamp renewals?—p. 329.

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S 14 Sum up the relative advantages and economy of using direct-current enclosed arc lamps for store lighting, as compared with alternating-current lamps.—p. 330.

S 15 What are the best arguments in favor of arc lighting (interior) as against (a) gasolene (b) acetylene lamps?—p. 330.

S 16 With the same care and skill applied, is there any reason why renewed incandescent lamps should not be as good as new ones?—p. 331.

S 17 How far can the target-diagram test of incandescent lamps be depended upon in determining the relative merits of different makes of lamps?—p. 332.

S 18 (a) What is the present status of the 250-volt incandescent lamp as to life, cost and efficiency? (b) Are the sockets marked "250 V," now on the market, suitable for this voltage?—p. 333.

S 19 What has been found to be the life of the Meridian lamp, and how does cost of free renewal compare with free renewal of incandescent lamps?—p. 334.

S 20 Are the Nernst lamps, 3 and 6-glower type, 220-volt, giving good satisfaction?—p. 335.

S 21 On what basis do you furnish installations and renewals of Nernst lamps as compared with standard incandescent lamps?—p. 336.

S 22 Does the Nernst lamp maintain its candle-power as well as a 3.5-watt incandescent lamp?—p. 337.

S 23 From a manager's standpoint, is a Nernst multiple-glower lamp preferable to a multiple-arc lamp? Is a single-glower lamp preferable to a Meridian lamp?—p. 337.

S 24 What per cent is the life factor of a Nernst lamp decreased by variation in voltage of 4 per cent or 5 per cent each side of normal? This fluctuation to occur, on an average, twice in an hour.—p. 338.

S 25 Is the objection raised by some that the mercury-vapor lamps are injurious to the eyes well founded?—p. 339.

S 26 Is the Cooper Hewitt mercury-vapor lamp considered satisfactory for window lighting, especially as regards the green tinge being noticeable?—p. 340.

S 27 Describe recent installations of latest type Cooper Hewitt lamps, giving results and comparison with arcs and incandescents for factory, machine shop, printing presses, etc.—p. 341.

S 28 (a) What is the best way of turning multiple lamps or electric signs on and off at predetermined hours—by patrolmen or by means of automatic time switch? (b) Have you found a practical and reliable time switch for the purpose?—p. 344.

S 29 What should be the characteristics of an incandescent lamp to operate satisfactorily on 25 cycles?—p. 345.

S 30 Where incandescent lamps are used for street lighting, what candle-power lamp should be used?—p. 345.

QUESTION

S 31 (a) Is the Nernst lamp much used for street lighting? (b) Does it prove satisfactory for such work, and what are its faults?—p. 346.

S 32 What are likely to be the causes of the sticking or welding together of the carbon points in alternating-current series enclosed arcs, especially when it occurs simultaneously in several lamps on a circuit?—p. 348.

T

HEATING, BATTERY CHARGING AND POWER

T 1 What are the central stations doing to help along the electric-heating industry?—p. 350.

T 2 Does the extensive use of heating appliances prove to be a desirable load?—p. 351.

T 3 What is the best method of charging storage batteries used in carriages?—p. 351.

T 4 Is there a good, strong, practical rectifier for charging automobile batteries from alternating-current circuits?—p. 352.

T 5 What is the experience of members with mercury-vapor rectifiers for automobile-charging stations?—p. 353.

T 6 (a) What is the usual price for current for charging the batteries of electric vehicles? (b) Is a minimum charge advisable? (c) Is it customary for the central station to fill the batteries with electrolyte?—p. 354.

T 7 How would the advent of a cheap and satisfactory alternating-current rectifier affect the alternating-current motor business? Would the direct-current motor drive the alternating-current motor out of the field?—p. 355.

T 8 Which is more important to the central station—high power factor or high efficiency in the apparatus receiving power from the station?—p. 356.

T 9 Does the average induction or synchronous polyphase motor take a balanced load?—p. 357.

T 10 Is the maintenance of a single-phase motor any more troublesome or expensive than that of the average direct-current motor?—p. 357.

T 11 What is the best practice, from an engineering as well as from an underwriter's standpoint, in designing the service leads and the fuses supplying induction motors? Should the service wires and fuses be of such capacity as to handle a continuous 100 per cent overload on the motors?—p. 359.

T 12 Is there any way to prevent throwing of oil from an oil ring bearing, especially on small motors and generators under 15-hp and more particularly under 5-hp?—p. 360.

T 13 Are the individual motor-driven refrigerating devices now on the market practical from a standpoint of economy and profit to central stations?—p. 361.

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T 14 Are there any electric-light stations that are furnishing current for motors operating water-works pumping plants situated at a distance from the station, and with what success?—p. 362.

T 15 (a) Is it good practice to use motor-driven pumps for city pumping for a standpipe system in a town of from 3000 to 5000 people? (b) Which are the best adapted—gear plunger pumps, duplex pumps or turbine pumps? (c) What would be the cost of installation, also rates per kilowatt-hour, for which it could be done to show a profit in a 24-hour plant?—p. 363.

T 16 What is the best way to handle elevators on alternating-current system having small units and light load?—p. 363.

T 17 What is the energy consumption per car mile of high-speed, hydraulic, electric-driven elevators?—p. 364.

T 18 What has been the experience with motor-driven, two or three-stage centrifugal pumps in connection with electric-hydraulic elevators; (a) with direct-current motors and (b) with alternating-current motors?—p. 365.

T 19 What measures should be taken to promote the sale of power to farmers for driving agricultural machinery?—p. 365.

T 20 What advantages has the induction motor over synchronous motors?—p. 366.

T 21 Give some method for switching large synchronous-motor units to the supply mains, avoiding the use of starting compensator or separate starting motor.—p. 367.

T 22 How do small electrically operated refrigerating machines compare in operating cost with ice, 300 pounds per day?—p. 368.

U

METERS

U 1 What has been the experience with prepayment meters?—p. 368.

U 2 What effect have slot meters upon sales; have they reduced or increased sales?—p. 369.

U 3 What satisfaction have slot-machine prepayment meters given; have they been found as efficient generally as the other meters? Assuming slot meters to be entirely satisfactory, would it be considered good policy to install them for any consumer who wished to be supplied with one, or would it be better to supply them only to doubtful consumers?—p. 370.

U 4 How can you satisfy the customer that his meter registers his consumption correctly?—p. 370.

U 5 What effective means, if any, have been found to make it impossible for a customer to beat a recording wattmeter, or what special precautions can be taken by an electric-light company to detect same?—p. 377.

U 6 What percentage variation from no load to 50 per cent overload should be allowable on consumers' meters?—p. 381.

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U 7 If a meter is found creeping forward, is it advisable to grant the customer a rebate?—p. 382.

U 8 What will be the effect on a 16,000 alternating meter to have 15,000 alternations or 17,600 alternations at the generator? —p. 385.

U 9 Why does a very slight jarring continuing about 12 hours out of 24 cause a meter to run gradually slower and slower, and how can it be remedied? The meter has to be replaced about once every ten months.—p. 386.

U 10 How often should consumers' meters be tested?—p. 390.

U 11 What is the best method of caring for meters; should they be carried to a test room for repairs and calibrating, or should they be calibrated in place?—p. 393.

U 12 Should a specific charge be made for a meter test that customer has requested when meter is found slow?—p. 396.

U 13 What is the best method of testing Thomson recording wattmeters on the customers' premises? Is there any convenient portable device that can be used as a variable load in making such tests?—p. 397.

U 14 What is the best way of keeping a meter record? This applies to the consumer's end of the service.—p. 401

U 15 Are commutator-type recording wattmeters correct for inductive loads?—p. 403.

U 16 What are the points to be considered in deciding what make of meter to use in order to get the best results?—p. 405.

U 17 What has been station experience for past few years with four types of bearings for integrating meters, as follows: (a) regular steel-ball pivot on round cup sapphire; (b) regular steel-ball pivot on flat diamond; (c) magnetic-flotation bearings; (d) ball and two-cup sapphires (present Westinghouse bearing).—p. 407.

U 18 What is the prevailing opinion among direct-current plants as to use of integrating watt-hour meters as against integrating ampere-hour meters, or equivalents of the latter?—p. 408.

U 19 For alternating-current work, as a general proposition, have meters of the Thompson (commutator) type proved nearly equal to the better class of induction meters, taking all points into consideration?—p. 408.

U 20 What is the cause and practical remedy for the reversal of error range in a Thomson polyphase meter connected up for testing, both sides in series or connected on three-phase circuits; that is, why does the meter run fast on low loads and slow on heavy loads?—p. 410.

U 21 What is a cheap and accurate way of determining the flux density of permanent magnets used for recording watt-meters? —p. 410.

U 22 What damage does a meter sustain by being exposed to changes of weather, etc., attached to outside of residences in semi-

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protected places. such as porches, etc., with overhead protection?—p. 412.

U 23 In metering a 3-phase circuit having a power factor less than unity by means of two single-phase meters, one meter runs slow; what determines which meter will be the slow one? —p. 414.

U 24 Is it advisable to use a balanced 3-phase recording wattmeter for metering the power taken by the average 3-phase motor? —p. 416.

U 25 What plan has been found to rectify delay in reading meters when located inside of buildings with occupants absent? This in view of the loss of time from a high-priced meter man's repeated calls.—p. 417.

U 26 What is the average cost of annual maintenance (a) for meters of direct-current type; (b) for meters of alternating-current type?—p. 418.

U 27 What percentage of the investment in meters would be a reasonable figure for the expenses of the meter department in a plant with about one thousand meters?—p. 418.

U 28 Has there been a satisfactory arrangement with wiring contractors whereby the location of meter loops are accessible to meter readers, and are they found to live up to such arrangement?—p. 419.

U 29 Does a peep-hole in the meter cover induce the consumer to tamper with and try to stop the meter?—p. 421.

U 30 Do repolished meter jewels and pivots give as good service as new ones?—p. 423.

U 31 What are the advantages and disadvantages of an excessively high torque in an induction meter?—p. 423.

U 32 Where is the best place to locate a meter in a private residence, considering convenience for reading and inspecting and the least inconvenience to the customer?—p. 424.

U 33 In small towns using, say, 300 to 500 meters, is it advisable to employ an experienced meter man, at yearly intervals, to go over all meters in use?—p. 426.

U 34 Which is the better method of handling a meter department in a small company supplying from 500 to 1000 customers? Should one man be employed to devote all his time to reading and testing meters, extending the reading over several days, or should the readings be made by several men, taken away from other duties on two or three days of each month, the testing to be done by one man, who also has other duties? If the former method were followed, how many meters should one man be able to take care of properly?—p. 428.

U 35 What method of metering current has been found best suited for installations consisting of single and 3-phase, 220-volt motors, resulting in an unbalanced 3-phase load?—p. 429.

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U 36 We are operating a 500-volt, direct-current, 2-wire circuit for power, and while our lines, motors and meters are protected by lightning arresters, we lose from 10 to 15 meters in the spring from lightning discharges. What is the best method of preventing this?—p. 430.

V

ADVERTISING

V 1 What do you consider the best method of advertising the electric-lighting business?—p. 431.

V 2 Is a monthly bulletin or paper valuable to small stations for advertising purposes?—p. 434.

V 3 Does newspaper advertising pay in towns of less than 5000 people?—p. 434.

V 4 In a city of 25,000, to what extent is it profitable to advertise by means of prepared printed matter mailed to prospective customers?—p. 435.

V 5 Of the various forms of advertising adopted by manufacturers, which appeals to you most strongly or best accomplishes its purpose? This with special reference to large and small advertisements in technical papers and indiscriminate and persistent circularizing.—p. 436.

V 6 (a) Do exhibit and display departments pay? (b) Could not a widely-announced exhibition of electrical novelties be arranged yearly, or oftener, to advantage?—p. 437.

W

CONTRACTS AND RATES

W 1 What is the remedy for customers using too much light on a flat rate, the town being too small for meter service?—p. 439.

W 2 What is the best and most practical way of changing from flat to meter rates; also the most favorable time for making such change?—p. 442.

W 3 Has the legality of the ordinary lighting contract been tested, and with what results?—p. 446.

W 4 Can any information be given relative to a system of charging without contract? Is it possible to hold customers without requiring a contract to be executed for a period of at least one year?—p. 446.

W 5 Are not public service corporations supplying electricity equally liable with railroads, etc., to charges of discrimination if their scale of rates or the discounts allowed depend upon the quantity of current delivered? If the size of the installation to be served is taken into consideration in connection with the sliding scale mentioned in the above question, can the sliding scale be justified?—p. 447.

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W 6 Is it a good plan to have the fixed charge per kilowatt-hour for all meter customers and then give discounts for payments at the office before a certain date, the discount to vary with the amount of customers' consumption?—p. 448.

W 7 At what price must electricity be furnished per kilowatt to compete with natural gas at 27 cents per 1000, for power purpose?—p. 450.

W 8 With gas at $1.25 for heating and $1.50 for lighting, what are the best rates that can be obtained for electric lighting? Both gas and electric companies under the same management.—p. 451.

W 9 For a town of 20,000 inhabitants, which is the most satisfactory way of selling current; at an average rate of ten cents per kilowatt-hour or on a sliding scale, 7 to 15 cents, according to consumption?—p. 451.

W 10 Is it better to tend as much as possible toward open rates applicable to all who come within specified classes as regards consumption of current, etc., or to make special rates and contracts with individuals, based on individual requirements?—p. 452.

W 11 Has any one found any legitimate objection to the system of charging for electric current known as the "Doherty Rate," as presented to the Cincinnati meeting in 1902?—p. 454.

W 12 Should motors of all sizes get the same discount for the same hours' service?—p. 454.

W 13 Should not the smaller consumer that burns his light from sun to sun be entitled to a meter rate nearly as low, if not quite, as the large consumer that uses only a portion of his lights all night, but uses the full capacity during the peak?—p. 456.

W 14 Will some plant using maximum-demand meters give average, highest and lowest yearly maximum demand per 16-cp lamp or per kilowatt connected, for various classes of business; for instance, for residences, for lodging houses, for saloons, etc.?—p. 457.

W 15 How can we best push the electric-heating business?—p. 458.

W 16 (a) Should different rates be made for using heating and cooking appliances than for regular lighting? (b) Are such appliances connected on light meter or on separate meter?—p. 459.

W 17 What rates are used for heating service, and are any special rates made for this class of load?—p. 460.

W 18 What rates are used for charging storage batteries, and are any special rates made for this class of load?—p. 460.

W 19 Is it good practice to install electric signs on contract, making special rates for same and having same controlled by time switches?—p. 461.

W 20 What is the best method of proving to consumers paying at meter rates that they are not paying for more current than they are using?—p. 462.

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W 21 What can be done to meet competition with gas engines? Has any company found it necessary to use special rates to keep out gas engines?—p. 464.

W 22 What system to you advocate for handling the business of the contracting department?—p. 465.

W 23 What provision is made in existing contracts for tests on arc or incandescent lamps for street lighting?—p. 466.

W 24 Should a contract for incandescent street lights specify when the lamps should be renewed, either as to number of hours' burning or as to the minimum candle-power to be allowed? —p. 467.

W 25 Should a contract for incandescent street lights specify initial or average candle-power, and what is a satisfactory method of testing candle-power of street incandescent lamps?—p. 467.

W 26 In wording a contract for street lighting, what is a fair description of a so-called "full-arc," or a "2000-candle-power" arc that will not be misunderstood and that will stand a fair test? Also a "half-arc," or a "1200-candle-power" arc?—p. 467.

W 27 What is a fair method of settling disputes between companies and cities as to whether the company is actually furnishing 2000 or 1200-cp lights?—p. 469.

W 28 By the use of what argument and figures can a prospective consumer be convinced that an electric motor is cheaper than a steam engine?—p. 469.

W 29 What do you consider a fair week's work, either in lamps or income, for a solicitor?—p. 472.

W 30 (a) What methods do you use to save clerical work for solicitors? (b) What system of reports, if any, do you use to check solicitors' work and keep them up to their best efforts? —p. 473.

X

ACCOUNTING AND STATISTICS

X 1 Where can I get information concerning best methods of electric-light and telephone accounting and statistics?—p. 475.

X 2 What is the best system of billing goods for wiring, current, etc.? —p. 475.

X 3 What are some of the best ways for keeping rent or meter accounts?—p. 475.

X 4 What is the best and easiest method of keeping a record of transformers and meters?—p. 476.

X 5 What percentage of depreciation should be charged on station and equipment?—p. 478.

X 6 What is considered a proper list of operating records for use in analyzing the operation of a steam plant? How much detail should be exhibited by these records in a 6000-kilowatt steam plant producing alternating current?—p. 478.

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X 7 What success has been obtained in devising and maintaining a systematic method of recording and satisfactorily analyzing all cases of trouble in the operation of central-station systems? —p. 480.

X 8 What is the average output per pound of coal (stating kind used) in plants using compound engines; size of plant 2000 to 5000 kilowatt?—p. 480.

X 9 What percentage of total generated output is lost or unaccounted for, and what is the percentage of each of the classes of such losses or unaccounted-for current?—p. 480.

X 10 In an Edison, three-wire, overhead, direct-current, 110-220-volt system, with mains interconnected and feeders arranged to give good regulation of voltage, about what per cent is lost between station meters and consumers' meters?—p. 481.

X 11 What is the best method of keeping record of connected load? —p. 481.

X 12 Is it not better to have the consumers' ledger segregated according to meter route, rather than alphabetically?—p. 482.

Y

MANAGEMENT

Y 1 (a) Is a day service justifiable in a small town, and what kind of power business can be worked up; (b) what kind of power rate should be charged?—p. 485.

Y 2 (a) What has been the experience of central stations in thawing out frozen water pipes? (b) How was the current limited to what the apparatus would stand?—p. 486.

Y 3 Will a small central station operating 1100 to 52 volts, 125 cycles, be warranted in changing over to 2200, 230-115 volts, 60 cycles, when transformers are all old, but wattmeters comparatively new (commutator type)? Power business of little consequence; no day circuit at present.—p. 488.

Y 4 What is the practice in inspecting wiring in a house wired when built, but to which current is not supplied until several years later? What charge, if any, should be made to the customer? —p. 489.

Y 5 In a town of 10,000 people, should a lighting company do house wiring and deal in fixtures?—p. 489.

Y 6 Is it advisable to charge a 5-per-cent penalty for non-payment of bills within ten days of date?—p. 491.

Y 7 (a) What amount per 16-cp equivalent of new business obtained do you spend for soliciting and for advertising? (b) Would you consider it advisable to increase or to decrease either or both of these items?—p. 492.

Y 8 (a) Do you charge for cutting of wires in connection with moving of houses? (b) Do you collect damages for shut-downs? (c) Have you ordinances regulating moving of houses?—p. 492.

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Y 9 An electric-lighting company has a 20-year franchise granting the right to use one side of the alleys for erection of its pole lines. Has any other company, either lighting, telephone or telegraph, the lawful right to use the same side of the alley by placing its poles between the wires of the first-mentioned company after said company has had its pole line erected and in operation? What is the experience of others in regard to such interference?—p. 494.

Y 10 Which is better practice—to charge for the fittings of the Meridian lamp or furnish them free?—p. 494.

Y 11 Who pays for the street connection, the light company or the consumer; that is, what is the prevailing rule?—p. 495.

Y 12 (a) Is it common practice among central-station managers to furnish free arc lamps on their commercial lines—i. e., the company pays the purchase price and the arc lamps remain the property of the company? (b) Are they as a rule put on flat or meter rate, and what is the usual rate charged on either?—p. 496.

Y 13 Under what conditions is a small central station, at present equipped with 133-cycle apparatus, justified in changing over to 60-cycle?—p. 498.

Y 14 What particular characteristics as to age, temperament and education do you consider most desirable and practicable in men for operating stations and substations?—p. 498.

Y 15 What set of written or printed rules and regulations are in use by electric-light companies, covering the government of employees, also as to proper precautions to be taken in doing hazardous work, etc.?—p. 499.

Y 16 Is it advisable to make a rebate to hold the consumer in case of a large bill, when the meter and meter readings are known to be correct?—p. 499.

Y 17 Is it good practice to insist on deposits from all consumers irrespective of their standing in the community, and if so, should the deposit be in proportion to the installation?—p. 501.

Y 18 (a) In case an installation has been passed upon by the city inspector as satisfactory, does the electric company have the right to refuse the service if it is satisfied the work has not been done properly? (b) In such case, can the householder, when he is willing to assume the risk, come back on the company for damages for failure to serve?—p. 503.

Y 19 What is the best method of marking incandescent lamps, at the time of issue, so as to guard against unprincipled people buying old lamps for junk and exchanging them for new lamps, where the company gives free renewals?—p. 503.

Z

MISCELLANEOUS

QUESTION

Z 1 What per cent of regulation is secured in large plants doing a power and lighting business?—p. 506.

Z 2 What is being done, and how, to utilize the exhaust from gas engine for hot-water heating?—p. 506.

Z 3 Are producer-gas plants complete with engine more economical in units of 75 to 125 horse-power than steam plants of equal size?—p. 507.

Z 4 Given a town of 3000 population wanting an electric-light plant, and having natural gas piped and sold at 15 cents per thousand feet, with coal delivered at $2.00 per ton, what shall I install in the way of engines, boilers and generators to justify an investment?—p. 507.

Z 5 Under equal conditions of total current generated in 24 hours, management, cost of coal and supplies, type of engines, boilers and auxiliary machinery, can a central station doing an exclusive business in alternating-current commercial and street lighting, deliver a kilowatt-hour at switchboard at the same cost that would prevail in a direct-current street railway station?—p. 507.

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A 7, 8. C 20. D 6, 16.

Kimball, R. E. N., Mgr. Kenosha Gas and Elec. Co., Kenosha, Wis.
D 6. E 3, 4, 18, 21. G 1, 3, 16. H 1, 2, 3, 4, 6, 8. J 2, 3, 12, 13, 15. K 3. S 8, 12, 23. U 1. W 29, 30. X 1. Z 4, 5.

Koester, Franz, 32 Park place, New York city.
G 1, 2, 3, 4, 8, 9, 18. I 1, 2, 3, 10.

Koiner, C. W., Prest. Madison County Gas and Elec. Co., Oneida, N. Y.
A 1. C 2, 5, 11, 16, 19. D 1, 8, 12. E 11, 16, 17, 19, 20, 21. F 4, 5.

G 1, 2, 3, 5, 7, 8, 12, 14, 15, 16, 17. H 17, 19, 21, 22, 25. M 10, 11, 13. N 1, 2. O 2, 4, 5. P 12, 16, 18, 19, 20, 27. R 1, 2, 7, 10, 11, 12, 16, 20. S 1, 2, 11, 15. T 10, 11. U 7, 9, 10, 11, 12, 16. V 1. W 6, 7, 8, 13, 26. X 5, 8. Y 1, 10, 11. Z 1.

Korst, P. H., Janesville Elec. Co., Janesville, Wis.
B 7, 13. F 6. O 8. R 26. U 33. X 12.

L

Landsberg, W. L., Statistical Dept., Chicago Edison Co., Chicago, Ill.
E 26. L 16.

Lanphier, R. C., Sangamo Elec. Co., Springfield, Ill.
M 14, 15, 16, 24. U 5, 6, 8, 9, 13, 15, 21, 22, 31.

Lansingh, V. R., Holophane Glass Co., New York city.
S 26, 31. Z 18.

Lauder, Geo. B., Supt. Concord Elec. Co., Concord, N. H.
B 9, 10. E 19. K 3, 6, 7. M 10, 12, 18. S 1, 2, 3, 11. U 7, 10, 11, 19, 21, 24, 28. W 1, 2, 6, 9, 10, 13. Y 1.

Laxton, Ralph R., Gen. Supt. Pascagoula St. Ry. and Pr. Co., Pascagoula, Miss.
B 15, 16, 17. K 12, 14, 18. M 20. P 37, 38, 40, 41, 43, 44. Q 18. 19, 20. R 25, 26, 28. S 30, 32. T 20. U 35, 36. W 28. Y 16, 17, 18. Z 19, 25.

Lee, E. E., Chicago Edison Co., Chicago, Ill.
C 9. F 1.

Lege, F. M., Jr., Beaumont Ice. Lt. and Refrg. Co., Beaumont, Texas.
K 12, 13. N 5. P 36, 38, 40, 41. S 30, 32. U 29, 30, 31, 32, 33, 34, 36. W 28. X 12. Y 16, 17, 19. Z 22, 23.

Legge, E. F.
P 42. R 13. Z 19.

Leland, G. B., Supt. The Stamford Gas and Elec. Co., Stamford, Conn.
C 6, 16. F 7. G 3, 5, 13. H 14. K 3, 9. M 10. P 1, 12. T 16. U 12, 24. W 2, 26. Y 8, 13. Z 5, 10, 12.

Lesley, Hugh, Elec. Storage Battery Co., Philadelphia, Pa.
L 5, 8, 9, 10, 11, 12, 13, 14, 18.

Lewis, Wm. M., Somerville, N. J.
K 12. U 29, 32, 33, 34, 36. Y 16, 17.

Lloyd, R. Louis.
V 1, 2, 3, 4. W 6, 12, 13, 20. Y 6.

M

MacKinnon, A. R., Mgr. Cheboygan Elec. Lt. and Pr. Co., Cheboygan, Mich.
B 13, 16. K 3, 10. M 6, 7, 8, 18. O 8. P 12, 14. R 7, 10, 11, 16. S 1, 2, 10. U 4, 7. V 6. W 1, 2, 10, 26. Y 5. Z 25.

Madison Lt. and Ry. Co., Madison, Ind.
O 4. S 32. U 4, 32. W 28. Y 11.

Maloney, J. A., Mobile Lt. and R. R. Co., Mobile, Ala.
  C 20. D 14. E 24.
Marsh, Converse D., New York city.
  V 1, 2, 3, 4, 5, 6.
Maunsell, C. R., Edison Elec. Ill'g Co., Topeka, Kan.
  J 2, 5, 12, 18.
McCabe, E. F., Lewistown Elec. Lt. Co., Lewistown, Pa.
  A 2, 3, 4, 5, 6, 7. D 7, 8. E 1, 2, 3, 11, 12, 13, 15. F 5, 6. G 16. H 15, 17, 21. J 8. K 3. M 10, 12, 13. P 12. U 4.
McCarty, Norman, Am. Diesel Engine Co., New York city.
  H 5, 6, 7, 9.
McDonald, Wm., Chicago Edison Co., Chicago, Ill.
  F 5, 7. M 9.
McKana, Geo. E., 139 Adams street, Chicago, Ill.
  L 17. W 14, 26. X 8.
McMillan, R., Statistical Dept., Chicago Edison Co., Chicago, Ill.
  K 12.
Messer, S. F., The Warren Water and Lt. Co., Warren, Ohio.
  S 16, 21. T 6.
Meyer, H. J., Shreveport Gas, Elec. Lt. and Pr. Co., Shreveport, La.
  D 16. K 18. M 19. P 2, 6, 12, 14, 21, 27, 28, 32, 37. Q 6, 8. R 10, 28. S 31. U 33. X 12. Z 25.
Mills, J. B.
  U 4, 13.
Mills, W. H., Webster Elec. Co., Webster, Mass.
  C 6, 7, 11, 20. E 15, 16, 19, 22. G 7, 12, 14. H 12, 20, 21. O 4.
Moore, W. E., Lewiston-Clarkston Co., Clarkston, Wash.
  A 1, 2, 3, 5. B 1, 2.
Morgenthaler, P. C., Chicago Edison Co., Chicago, Ill.
  U 9, 15, 18, 19.
Moultrop, I. E., The Edison Elec. Ill'g Co. of Boston, Boston, Mass.
  A 2, 3, 4, 7, 8. C 6, 7, 8, 11, 13, 15, 16, 17, 20. E 11, 12, 13, 15, 25. G 1, 2, 3, 5, 8, 9, 11, 12, 13, 14, 15, 17, 18, 22, 23, 24. H 11, 18, 21. I 1, 2, 3, 4, 10, 13, 14, 15. K 12. L 10. M 4.
Munro, W. S., Chicago Edison Co., Chicago, Ill.
  K 8.

N.

New York Edison Co., New York city.
  A. A. P. S 1, 18, 19. T 11, 16. U 28.
  A. H. A. U 1, 3, 5, 6, 9, 10, 11, 13, 15, 16, 18, 19, 21, 24.
  C. A. L. S 13. W 1, 2, 4, 10, 12.
  C. H. B. C. S 25, 26, 27.
  C. K. N. H 1.
  C. W. R. H 21. P 23. T 1, 2. W 17. Y 2.
  E. A. M. S 2, 3, 6, 14, 15.
  E. A. N. T 3, 4, 5, 6. U 5, 32. W 18.

G. H. H 7, 9. T 7, 9, 13, 17, 18.
J. P. R., Jr. S 20, 21, 22, 23, 24.
M. P. R. K 14, 18. M 6, 8, 18, 19, 21. P 5, 6, 9, 12, 14, 16, 17, 18, 19, 20, 24, 27, 43. R 1, 2, 5, 6, 7, 9, 10 11, 12, 21, 22, 24, 25. S 1, 3, 10, 11, 32. T 20.
W. R. B. U 4, 7, 12, 25, 29. W 20.
W. T. M. P 12, 27, 34. R 7, 21, 22.

O

O'Connell, D., The Union Elec. Co., Cazenovia, N. Y.
N 5. U 32. W 28. Z 21, 22, 23.
Oviatt, W. T., Connecticut Ry. and Ltg. Co., Bridgeport, Conn.
K 3, 10.
Owen, F. B.
U 25, 28.

P

Palmer, G. E., Pettingell-Andrews Co., Boston, Mass.
R 26. S 3, 5, 7, 10, 28. Z 12.
Partridge, Warren, United Elec. Co. of N. J., Orange, N. J.
P 4, 19, 28, 40, 41. R 10, 14. T 11. U 12, 28, 33.
Penniston, C. D., Kenosha Gas and Elec. Co., Kenosha, Wis.
W 30. X 3.
Peters, A., Excelsior Springs Lt., Pr. and Water Co., Excelsior Springs, Mo.
C 18. D 3. E 1, 22. G 7, 9, 16. K 3, 6, 7, 9, 10. L 1, 2, 3, 6, 9, 12. M 6, 10, 13. P 4, 7, 12, 13, 16. R 11, 16, 20. S 6. T 12. U 7, 9, 10, 15. W 2, 13. X 10. Y 3, 12. Z 17.
Peters, Chas. H., Mgr. The Durango Lt. and Pr. Co., Durango, Colo.
E 16, 17. H 28. K 2, 3. M 6, 11. N 1, 3. O 2, 4. P 2, 9, 12, 19. R 7, 11, 13, 16, 20. T 12. U 6, 7, 9, 12, 22, 25. V 2, 3. W 1, 2, 9, 20, 27. X 2, 5. Y 2, 3, 5, 9, 11, 13.
Peterson, E., Mgr. Crookston Water Works, Pr. and Lt. Co., Crookston, Minn.
W 28.
Philadelphia Elec. Co., Philadelphia, Pa.
C 20. D 12, 15, 16. E 26. F 8. H 29. G 6. I 6, 11. K 18. O 7. S 21, 23, 26, 28. T 4, 5, 7, 13, 17, 20, 22. W 21, 29, 30. X 3, 6, 11. Y 4. Z 12, 15.
Pierce, Geo. M., Brodhead Elec. Lt. Co., Brodhead, Wis.
B 1.
Pope, Harry D., Electric Power Co., Ltd., Boise, Idaho.
B 1, 2.
Porter, Louis I., Chicago Edison Co., Chicago, Ill.
M 7. U 13.
Proutt, F. G., Memphis Consol. Gas and Elec. Co., Memphis, Tenn.
A 4. K 3, 7, 8, 9, 10. P 12, 13, 24. Q 2, 5, 12, 16, 17, 23. R 14.

16, 21, 22, 28. T 7, 10, 16. U 4, 7, 11, 12, 28. W 1, 3, 10, 28. Y 5, 11, 14. Z 21.
Prusinowski, S., Chicago Edison Co., Chicago, Ill.
X 9.

R

Radley, G. R., Milwaukee Elec. Ry. and Lt. Co., Milwaukee, Wis.
M 13. P 7, 8. U 5.
Richardson, Geo. W., Cicero Lt., Ht. and Pr. Co., Oak Park, Ill.
C 2, 3, 6, 7, 11, 12, 19. D 3, 9, 11, 13. E 1, 6, 11, 12, 15, 16, 17, 19, 20, 21, 22, 23. F 4, 5, 7. G 1, 5, 7, 9, 10, 12, 13, 14, 17, 22. H 2, 12, 14, 17, 21, 22, 24, 25, 26, 27. J 1, 9, 11. K 2, 5, 6, 9, 10, 11. M 1, 5, 9, 11, 18. N 2, 3, 4. O 6, 8.
Richardson, Thomas S., Denver Gas and Elec. Co., Denver, Colo.
R 3. S 30. U 19, 22. W 20. Y 19.
Roberts, E. R., Nernst Lamp Co., Pittsburg, Pa.
S 22, 24.
Robinson, J. S., Columbia Water and Lt. Co., Columbia, Tenn.
C 3, 4, 9. E 20, 21. F 5. H 21, 29. S 1.
Rockland Lt. and Pr. Co., Nyack, N. Y.
W 28.
Roland, W. B., Supt. Cape May Lt. and Pr. Co., Cape May, N. J.
A 3. C 2, 18, 19. D 2. E 1, 4, 15. F 5. G 10. H 16.
Rollins, N. A., Chicago Edison Co., Chicago, Ill.
K 10.
Roper, D. W., Chicago Edison Co., Chicago, Ill.
K 19. T 21.
Rowe, Bertrand, Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.
K 17. M 19, 20, 21, 24.
Russell, H. S., Denver Gas and Elec. Co., Denver, Colo.
E 27. H 21. M 6, 7, 10, 18. X 4.
Ryder, H. E., Marlborough Elec. Co., Marlboro, Mass.
P 1, 12. U 4, 7. W 15.

S

Saunders, J. D., The Northwestern Elec. Ht. and Pr. Co., Kearney, Neb.
B 9. C 11. D 3. E 16, 19, 21, 22. G 1, 7. K 2.
Schildhauer, Edw., Chicago Edison Co., Chicago, Ill.
K 16. M 3, 22.
Seattle Electric Co., The, Seattle, Wash.
K 3, 4, 9. M 10, 18. P 13. R 8, 17, 23. S 11.
Sees, W. L., Commonwealth Elec. Co., Chicago, Ill.
P 5, 11, 12, 14, 15, 19, 21, 24, 25, 27, 29.
Sexton, Geo. T., Chicago Edison Co., Chicago, Ill.
L 18.
Shain, Clinton D., Beacon Lt. Co., Chester, Pa.
P 4, 5, 7, 12, 18, 19, 34. R 7, 8, 9, 10. T 12. W 25. Y 2.

Sharpe, Fred B., Liberty Lt. and Pr. Co., Liberty, N. Y.
B 17. D 5, 16. E 26. F 8. H 28. M 7, 8, 10, 13. P 1, 4, 9, 12, 18, 22, 23, 26, 37, 38, 41, 43. Q 11. R 7, 9, 16, 18, 20. S 20, 21, 22. T 19. U 4, 7, 9, 16, 17. W 6, 24. X 6. Z 15, 24.

Shaw, Chas. N., Ch. Engr., Newburgh Lt., Ht. and Pr. Co., Newburgh, N. Y.
A 6. B 7. C 2. D 3, 5. E 17, 19. H 6, 21. N 3. O 8. Z 10.

Sheridan, Jos., Secy. Buchel Pr. and Irrigation Co., Cuero, Texas.
Y 19.

Sims, W. F., Chicago Edison Co., Chicago, Ill.
A 2, 3, 4.

Smith, F. Elwood, The Edison Elec. Ill'g Co. of Boston, Boston, Mass.
M 11, 18. O 5. P 12, 24, 27. R 19. S 1, 30. U 11, 12, 25, 32, 33. V 3. W 1, 2, 6, 9, 13, 16, 17, 18, 23, 24, 25, 26. X 4. Y 8, 16. X 12. Z 11.

Smith, P. J., Chicago Edison Co., Chicago, Ill.
S 5, 6, 12.

Springer, G. B., Chicago Edison Co., Chicago, Ill.
Q 11, 15, 16, 27.

T

Taylor, E. A., Denver Gas and Elec. Co., Denver, Colo.
Z 11.

Thomas, Percy H., Cooper Hewitt Elec. Co., 220 W. 29th street, New York city.
T 3, 4, 5.

Thomson, W. H., Jr., Corsicana Gas and Elec. Co., Corsicana, Texas.
H 24. M 10. T 14. U 4, 19. W 7. Y 5, 8.

Tidd, Geo. N., Marion Lt. and Htg. Co., Marion, Ind.
W 2, 3, 9. Y 3.

Titzell, W. W., Public Service Corp. of N. J., Jersey City, N. J.
A 1, 2, 6. B 2, 3, 5, 9, 13. C 1, 2, 3, 4, 6, 9, 11, 13, 15, 19. D 1, 2, 3, 10. E 1, 3, 5, 11, 12, 15, 17, 19, 20, 22, 23. F 1, 3, 5. G 1, 3, 5, 6, 7, 8, 13, 14, 16, 21, 22. H 1, 16, 17, 18, 21, 23, 25. P 3, 4, 14, 16, 17, 18, 19, 24, 25, 27, 32, 34. U 4, 5, 6, 7, 8, 9, 10, 13, 16, 22, 24.

U

United Elec. Lt. Co., Springfield, Mass.
A 2, 3. B 3, 4, 6, 7. D 5. E 10, 11, 12, 14, 19. G 21. I 11. M 10, 13. P 28. 32. Q 3, 12. S 17, 19. T 1, 2. U 4, 10, 28. V 1. W 16. Y 10, 11.

Unsigned.
B 8. D 2, 4, 17. F 5. G 22. H 10. I 6, 11. J 6, 9. K 16. P 27. T 16. U 4, 5, 6, 7, 9, 10, 11, 12, 13, 15, 16, 19, 20, 22, 23, 24, 25, 28, 29, 31, 32, 33, 34.

Uptegraff, J. M., Sewickley Elec. Co., Sewickley, Pa.
S 31.

V

Vaughan, E. A., Antigo Elec. Lt. Co., Antigo, Wis.
P 14, 18. U 4.

Veser, L. O., Power Sta. Dept., Rock Creek Power and Trans. Co., Hames, Ore.
B 17. K 14. M 19. P 37, 38.

Vredenburgh, La Rue, The Edison Elec. Ill'g Co. of Boston, Boston, Mass.
V 1, 2, 3, 4, 5, 6.

W

W. H. C.
K 3, 4, 7, 8, 9, 10. L 1. M 10, 11. P 8, 14, 16, 17, 19, 28. R 2, 7, 10, 12, 15, 16, 17, 20, 21, 22. U 7, 11, 12, 22.

W. H. W.
H 26, 27.

W. L. K.
H 3, 4, 6, 8. J 13. P 24. W 1, 2.

Wagner, E. A.
R 2.

Wagner Electric Co., St. Louis, Mo.
K 3.

Walden, A. E., Calumet Ltg. Co., Chicago Heights, Ill.
B 6, 7, 9, 12, 13. C 6, 7, 8, 9, 14, 16. D 3, 4, 5, 11. E 7. F 2, 3. H 1, 2, 4, 7, 9, 15. K 10. M 10, 11, 18. R 2.

Wallace, Newton, Engr., Mass. Agrl. College, Amherst, Mass.
J 2, 3, 7, 10, 16, 19.

Walsh, T. J., Chicago Edison Co., Chicago, Ill.
X 12.

Watson, L. E., The Northwestern Elec. Ht. and Pr. Co., Kearney, Neb.
B 1. M 1, 10. R 7, 20. U 4, 7. V 3. W 1, 2. Y 8, 11. Z 7.

West, R. V., Kanawha Water and Lt. Co., Charleston, W. Va.
Y 3, 6, 11, 12. W 1, 2, 6, 7, 9. U 11. 19.

Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.
K 4, 11, 15, 16, 18. R 23, 24, 27. Z 19.

Whitaker, J. S., Supt. Rockingham County Lt. and Pr. Co., Portsmouth, N. H.
K 7, 8, 9. U 4. W 10, 13.

Whitton, W. H., New York Edison Co., New York city.
H 12, 13, 25, 28. I 4, 7. J 14.

Wiatte, Wm., Chf. Engr. Fond-du-Lac, Fond-du-Lac, Wis.
C 1, 2, 6, 7, 8, 19. E 17, 19, 20, 21, 22. G 1. H 21.

Wilcox, N. T., The Lowell Elec. Lt. Corp., Lowell, Mass.
Q 18, 23. R 24, 25.

Willard, G. F., Denver Gas and Elec. Co., Denver, Colo.
B 1. C 2, 7, 11. E 13, 19. F 1. G 7, 8. P 27. T 9, 10. U 9, 11, 12, 19. W 19.

Willcox, F. W., General Elec. Co., Harrison, N. J.
S 17, 18, 19.

Williams, John R., The Elec. Storage Battery Co., Philadelphia, Pa.
L 2, 4.
Williams, Paul F., Chicago Edison Co., Chicago, Ill.
P 8, 12, 18, 25, 26.
Williamson & Co., F. L., Clay Center, Kan.
A 3, 4, 5. B 13. N 5. P 2. W 2. Y 1, 2, 12.
Wolvekamp, W. H., Lawrence Gas Co., Lawrence, Mass.
L 1, 2, 3, 4, 6, 7, 8, 9, 12, 13.
Wood, C. D., Jr., N. Y. Edison Co., New York city.
T 7, 8, 19. S 7.
Woodbridge, J. Lester, The Elec. Storage Battery Co., Philadelphia, Pa.
L 1, 6.
Woods, H. P., Supt. The Rappahannock Elec. Lt. and Pr. Plant, Fredericksburg, Va.
P 21. O 8.
Wright, C. M., Pueblo, Colo.
K 3. S 15. W 1, 8, 13, 15, 16, 19. Y 5, 10, 12.

Y

Young, O. H., Ch. Engr. Wabash Water and Lt. Co., Wabash, Ind.
C 4, 10, 11, 19. E 19. G 7. H 21. K 2. O 4.

Z

Zimmerman, W. H., Mgr. De Kalb-Sycamore Elec. Co., De Kalb, Ill.
T 14. W 23. Y 6, 11, 12.

Wrinkles

H. C. ABELL, *Editor*

WRINKLES

A

RECORDS, SCHEDULES, REPORTS, ETC.

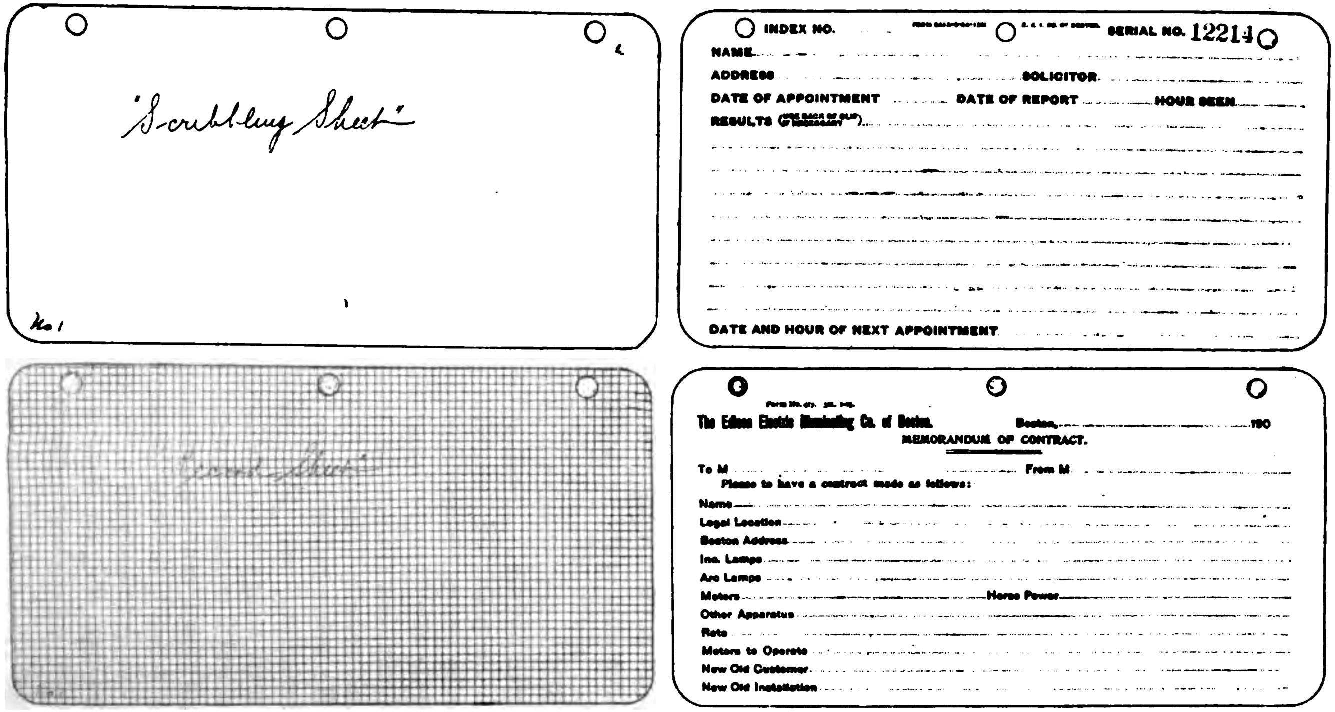
A 1

Solicitors' Hand Book

A method of saving clerical work for solicitors and yet enabling them to keep records of their business and leave a copy of their figures with the customer.

The pages, four by eight inches, are bound in a Unimatic loose-leaf book. The book contains an index, all the prices of the company, including power, light, heating, etc., blue-print tables for convenient figuring of prices, data on engineering, general orders to solicitors, general information regarding cost for lighting and power, Welsbach competition, pressure-gas competition, etc. Being of the loose-leaf form, new orders, prices, and data can easily be substituted for those out of date, and the old prices, data, etc., can be collected and destroyed. In the back of the book are plain sheets of paper which are called "scribbling sheets." Each solicitor has a piece of carbon paper which he places between two sheets. When he sees a customer he writes the customer's name, address and the date on the top of the sheet, and he figures the consumption on the basis of the installation and the number of hours burned, and then endeavors to close with the customer for a contract.

He writes on the bottom of the sheet, "Please preserve this for reference," and takes out the original sheet, hands to the customer, brings in the carbon copy and keeps it in a card catalogue, which contains the months and days of the month. When he has closed with the customer the figuring is filed under the proper initial in the card catalogue. Therefore, when the solicitor comes in, practically all of his clerical work is done for the day, besides impressing the customer with the fact that we do our work under correct business methods.



"Scribbling Sheet"

No 1

INDEX NO. E. E. I. Co. of Boston. SERIAL NO. 12214

NAME

ADDRESS SOLICITOR

DATE OF APPOINTMENT DATE OF REPORT HOUR SEEN

RESULTS (USE BACK OF SLIP IF NECESSARY)

DATE AND HOUR OF NEXT APPOINTMENT

"Record Sheet"

The Edison Electric Illuminating Co. of Boston. Boston, 190

MEMORANDUM OF CONTRACT.

To M From M

Please to have a contract made as follows:

Name

Legal Location

Boston Address

Inc. Lamps

Arc Lamps

Motors Horse Power

Other Apparatus

Rate

Meters to Operate

New Old Customer

New Old Installation

PAGES FROM SOLICITORS' HAND BOOK

In case of any "kick" in the future as to the size of his bill, our department of claims and adjustments will ask the customer for his copy of the solicitor's figuring. In case the customer does not have it they can ask the solicitor for it and any claim of misrepresentation on the part of the solicitor to the customer can thus easily be checked.

The solicitor, on coming in from his day's work, makes out a Serial Report about the same size as the sheet in the *Solicitor's Hand Book,* which serial report comes to me. The serial report that contains no business is set aside and either myself or a special solicitor sees the customer and endeavors to secure the business. In this way, everything possible is done to interest the customer. To be just to our solicitors, we very seldom close with a customer after they fail to secure the business.

We have in the *Solicitor's Hand Book* what we call "record sheets." These are for the solicitor's personal use. If he has any data, engineering or otherwise, that he wishes to preserve, he makes them on these sheets. You will notice that we have good paper and check lines to a tenth of an inch, so that any drawing or table can easily be made on them; being bond paper, it will last indefinitely. If necessary, they are reinforced with linen tops and the holes restamped, which makes them practically indestructible. The data that the solicitor puts on these sheets are his own property, and it is understood that, in case he leaves the company, he can separate these sheets and retain them. I enclose a sample of the "scribbling" and "record" sheets.

Every serial report is sent to the head of the "Follow-up" department of advertising, and the results of inquiries sent to us are taken from the serial reports. This method gives the Follow-up department a check on everything that is sent them. This method is a great advantage over the old system of card catalogues in that the clerical work now performed is more than cut in two, and it is very seldom that a man spends more than an hour a day in clerical work.

The serial reports are kept filed in my office and can be referred to at any time in case of inquiry from officers of the company. Solicitor making the serial report takes a carbon copy, which he retains in his card catalogue, so you see we have a double check; in case one copy is lost it is easy to find a duplicate.

The serial report is the same size as the "scribbling" sheet and perforated to carry in the hand book, so is also the ***Memorandum for Contract,*** which must receive my initial before contract blanks are gotten out. I enclose a sample of the serial report and of a memorandum for contract.

CHARLES H. HERRICK, Boston, Mass.

A 2

Station Records and Distribution Orders

Rules and Regulations of the Electric Department of the Elmira Water, Light and Railroad Company.

1. FIRST.—Station work. All work in connection with the running or care of station. Engineers in charge.

SECOND.—Line work. All work in connection with outside lines or light. Head lineman in charge.

2. The engineers will have general charge of machine and boiler rooms during their respective runs, and will be looked to and held responsible for operation and condition of same. It will be their duty to see that the machine and boiler rooms are kept in perfect order, as well as everything contained in same, valves and stuffing boxes packed and engines properly keyed. Engineers or machine tenders will not *both* absent themselves from the floor at the same time, nor for more than ten minutes at a time.

3. Engineers and firemen must see that engines, machines, shaftings, belts, steam piping, tools, boilers, etc., are kept clean and in first-class order. Firemen must not leave furnace doors open when cleaning fires or leave boiler room, and must also shut off the draft in ashpit, also fires must not be allowed to burn too low before cleaning, as it is not always necessary, and they must be cleaned twice a day. Engineers will be held responsible if same is not done.

4. Every boiler must have flues cleaned once a week.

5. Every boiler must be cleaned and inspected once each month.

6. Every boiler must be blown both surface and bottom once in twenty-four hours.

7. Machine room must be mopped out once a week and cleaned daily.

8. The lights must start and stop on time.

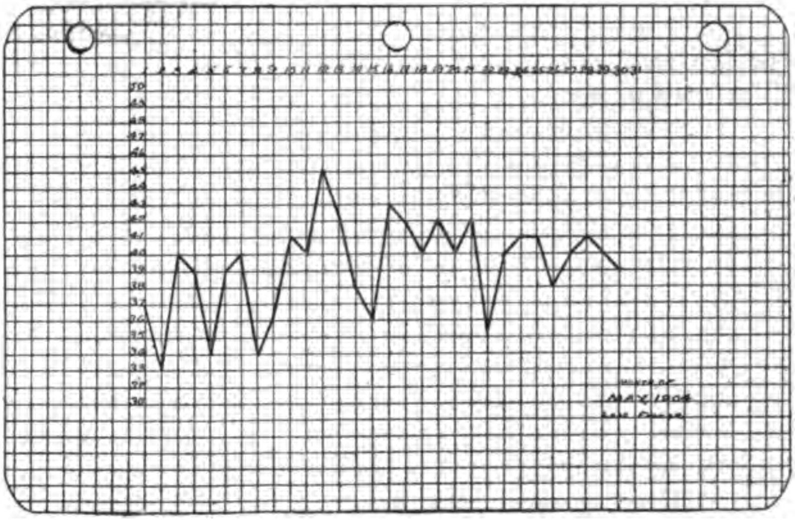


FIG. 1

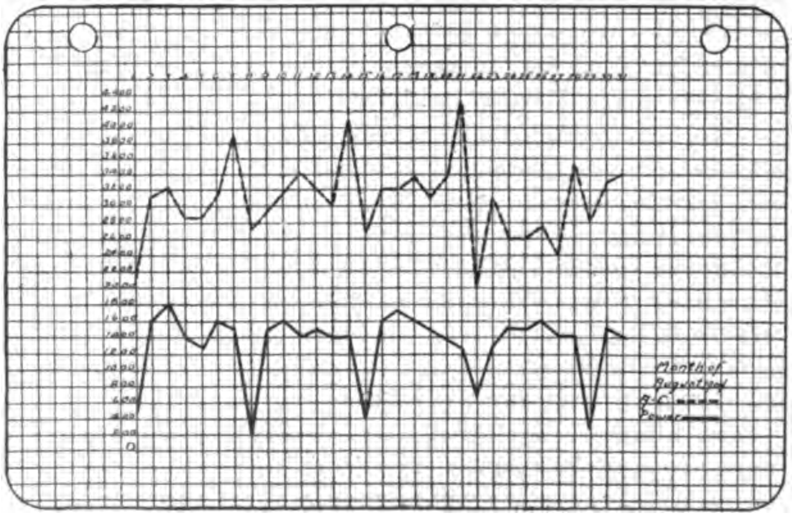


FIG. 2

STATION RECORDS, ELMIRA WATER, LIGHT AND RAILROAD COMPANY

9. Doors to machine room must be kept locked when not in use.

10. The station must never be left alone, and engineers must see that machine tenders, firemen and helpers do the work that is assigned to them.

11. Toilet rooms and closets must be kept clean and in order. A place is provided for all tools and wrenches. When you have finished using a tool see that it is returned to its proper place.

12. *Everything in and about the station must be kept clean and in order, and no man will be excused for a violation of this rule.*

13. Keep sharp lookout for fire, and see that fire apparatus is frequently tested and that same is in order.

14. Oily waste must be kept in cans, and same must be cleaned out and waste burned every day.

15. No smoking allowed in basement or store rooms.

16. Never go near belts, dynamos, switchboards, engines, shafting, boilers, or machinery of any kind, unless you are fully informed and instructed how to do so.

17. Never step through or over running belts, or moving machinery of any kind.

18. All circuits must be tested each day and the conditions of same noted on the blanks provided for that purpose and reported at office and blackboard.

19. Engineers must make out a regular daily report on blanks provided for that purpose. Machine tender must not leave floor until tender relieving him takes his place. In case an arc machine should not start and circuits apparently be all right, try another machine, or look over the machine in use and see if there is anything wrong with same, and lineman and machine tender must work together. Machine men must disconnect and ground all arc circuits as soon as current is shut off in the morning, and only remove same in time to start at night.

20. Linemen and all employees are positively forbidden and warned from working on any "live circuit" of over 500 volts without rubber gloves, which will be furnished by the company, and they must use all possible care.

21. Do not touch or handle any electric wire or apparatus of any sort while standing on the ground, or while in contact with

any iron work, unless your hands are covered with rubber gloves, or your tools are provided with rubber-covered handles.

22. If at any time it is necessary to stand on the ground, or any surface not insulated from the ground, while handling electric wires or apparatus, rubber boots or an insulated stool should be used.

23. Linemen and all employees who have work to do on "live circuits" must use the rubber gloves provided by the company.

24. Never handle an electric wire or apparatus with both hands at the same time, and in handling wires or apparatus always treat the same as if it carried a dangerous current, either dead or alive, and under no circumstance allow yourself to make contact between two or more wires at the same time.

25. Never take it for granted that a circuit is "dead." Always handle a wire as if it were "alive."

26. In moving wires hanging on or lying over electric light wires, lamps or fixtures, use a dry hand line.

27. Linemen must keep themselves posted and know each day the starting and stopping time, and all circuits must be closed and work stopped one-half hour before starting time.

28. Under no circumstances must the linemen keep the lights from starting on time.

29. Lineman must not interfere with switchboards or handle same in any way, but if work is to be done on any circuit, alternating, direct or arc, lineman must report such work to machine tender and notify him to open the circuit at switchboard and place "warning card" on same. *He must see that the machine tender does this at once.*

30. Never open a circuit unless notices have first been placed upon switchboard by the machine tender.

31. He must also order this card removed before starting time, and if notice is telephoned to station, he must call machine tender to the telephone and notify him that work has been stopped and line is clear. Machine tender must not remove "warning card" or close switch until he has notice from linemen, and he must receive word direct.

32. Head lineman, in erecting arc lights or converters, must see that same conforms to rules of Underwriters' Association of New York State.

33. Two hours before starting time, head lineman must ascertain from machine tender if arc circuits are "closed" and at starting time must be on hand to see that same start.

34. Head lineman must also see that lines are clear on Sunday.

35. Head lineman must see that arc lamps and converters are kept in order, and when not in use, that same are promptly returned to station, and all lines in repair.

36. Tools used by linemen and inspectors must be provided with insulated handles of hard rubber, or other equally good insulator. It is the duty of each employee to look after his tools, and see that they are in good order, especially as to their insulation.

37. Never use porcelain knobs where exposed to moisture or the weather, and never use them anywhere else if glass can possibly be used.

38. Porcelain knob circuit-breaks may be used where necessary, provided not more than two lamps are on the loop. In making them, paint and insulate with tape the joints in connecting wire of loop.

39. Never place the line where it can get against a sign, cornice, roof, pole, or anything else, where exposed to the weather, unless it would first rest against glass. Rubber tubing is not safe as a guard where exposed to moisture or the weather. Use iron brackets and glass tubing always in such places.

40. Always run wires in straight parallel lines, and make square turns where possible. Twelve inches between wires is the proper space for arc-lighting circuits, where practicable.

41. Never fasten a cut-out box or converter against the wall.

42. Never fail to put in "drip loops" in line where entering buildings. In all electrical work remember where insulation is desired it can never be TOO GOOD, or when contact is desired can you ever make it TOO GOOD OR STRONG.

43. In removing lamps ordered out, always close the loop at the line where it was originally cut in, and remove all dead wire. Never leave dead or unnecessary wire in circuit. Under no circumstances leave a converter in circuit that is not in use.

44. Always use iron pins on arms where wires turn a corner or leave the line.

45. *Never screw an insulator on iron pin or circuit-break very tight, nor without first putting inside the glass a strip of paper*

folded twice or three times or a piece of rag. This will prevent the glass being broken, as iron expands with heat nearly twice as rapidly as glass, and unless there is room enough, the difference in temperature between winter and summer would burst insulators in summer which were placed in winter.

46. In connecting line to lamps hung from suspension wire, put up wire in such a manner that same will not kink or twist, and if necessary use flexible wire. Solder and tape same as other joints. *Arrange the length of the wires leading to lamp so the lamp frame will not shadow the roadway of either street.*

47. Never tape a joint until it is soldered. Leave it bare until it can be properly finished, if you are compelled to so leave it, and never leave it unsoldered twenty-four hours.

48. *Always avoid temporary work.* Your orders are at all times to do what you do thoroughly.

49. When working on a circuit always keep it "closed," unless you are able to have it tested O. K. during the day from the station at 10 o'clock, and from 3 to 4, or as agreed with machine tender.

50. When placing guard wires on street crossings always use iron pins and glass insulators to attach both ends of guard wires to; never tie on cross-arm or pole. In stormy weather when they may be of use, they would be dangerous every way.

51. In working on lines all circuits *must at all times* be regarded as *alive and grounded.* The line you are on may "come alive" at any time—be careful.

52. Be careful that all tools are securely fastened in your belt when working on pole or ladder, and in handling wire and lines on poles have a proper regard for the safety of those walking or driving below.

53. When working on poles always use your safety belts, as well as other safety devices you are requested to use. It takes but little time to make yourself safe, and many weeks to mend a broken bone.

54. Never lay tools down when above the ground.

55. You should take necessary time and precaution for your own and the protection of others at all times.

56. House wiremen must see that all their work complies with the requirements of the Underwriters' Association of New York State.

57. Head wireman must report at once to office the starting and stopping of lights and must make out "wiring slip" for all material or supplies used in his department.

58. Storekeeper must keep a careful account of all goods or supplies received or issued, and nothing must be taken from storerooms without same is first charged to its proper account and entered on books provided for that purpose.

59. Trimmers and inspectors must never stand on ground or any metallic substance in handling lamps, and must always use rubber gloves provided by the company. In starting to trim a circuit always test same first to see that it is not crossed by a "live line."

60. Lamp trimmers and others engaged in the care of lamps must see that switch putting the lamps in circuit is turned off before they handle the lamps in any way, and they must be careful and see that switch is turned on after trimming the lamp, and must use the stand provided for them, and ground each lamp while trimming, and report in person and by telephone when they are off the line at night to allow of starting on time.

61. Inspectors must report to machine tenders upon returning to the station.

62. Company badge will be provided for each employee, and same must be worn where it can be plainly seen. Badge, keys, street-railway pass, rubber gloves, and all property of the company must be surrendered upon leaving the employ of the company.

63. Under no circumstances attempt an experiment or expose yourself or others to any risk or danger.

64. Intemperate men are not wanted.

65. Strangers and visitors will not be allowed in the station without permission from the office.

66. In case of serious trouble send for at once or call by telephone the superintendent.

67. Inspectors must answer all calls, attend to "trouble" promptly, and return at once to the office, and at all times must be civil and polite to customers.

68. All men are expected to be promptly on hand and to do the duty assigned to them. Extra time will be allowed only when a previous arrangement is made with the superintendent, and time lost will be deducted, for "it is a poor rule that will not work both ways."

69. Any employee having a complaint to make of another can do so to the superintendent, but he must be prepared to make his statement in the presence of the one he complains of. Each shall have an equal right to be heard.

70. In case of any misunderstanding or trouble of any kind, go at once to the superintendent for explanation or advice, and all employees are at liberty at any time to ask for any information pertaining to the business, and he will explain to them what they do not understand. Try constantly to perfect yourself.

71. Experimenting of any kind will not be allowed, and practical jokes, boy play, profanity or indecent language will not be tolerated one moment. Employees must and will not be allowed to make remarks before customers for any cause whatever, or against the company or any of its employees in the presence of a customer or any outsider.

72. Work and pull together in the interest of yourself and company, and you will find it the surest way to advancement and your own success.

73. All the above rules will be rigidly enforced. *Notice* is hereby given that if any employee violates or neglects any of them he does so at his own risk.

RULES FOR RAILROAD LINEMEN

First.—All line tensions should be taken off the trolley wire at the end of both tangents to the curve. This can be done by running strain wires to take up this tension.

Second.—The location of the curve of the trolley wire should not be directly over the center of the track, except at the point of tangency, but should depart from this curve toward the center, the departure being greater as the radius of the curve decreases. For a 50-foot curve the trolley wire should be eight inches inside of the center line of the track, at center of 90 degrees curve. (See Figure 1.)

In regard to spacing the pull-offs around the curve Table L shows the distance apart that they should be placed in order that the sides of the polygon formed by the trolley wire and pull-off will not be such an angle as to throw the trolley when passing around these curves. In any case the deflection of the trolley wire at any one pull-off ear should not be more than 10 degrees.

TABLE L

Radius in Feet	Distance between Centre of Track and Centre of Trolley	Distance between Pull-off on Curve
35	14 feet	6 feet
40	12 "	7 "
45	10 "	8 "
50	8 "	9 "
55	7 "	10 "
60	7 "	11 "
70	6 "	12 "
80	6 "	12 "
90	5 "	12 "
100	4 "	12 "
120	4 "	14 "
140	4 "	14 "
160	3 "	14 "
180	3 "	14 "
200	3 "	14 "
250	3 "	16 "
300	2 "	16 "
350	2 "	16 "

With curves laid out with a spiral between the curves and the tangent (as on the Sullivan Street line) it is not necessary to make any difference in guying the trolley wire.

Sheet 2 shows a number of methods of locating pull-offs in order to hold trolley wire to the proper curve. The original method consists in attaching the pull-off guy directly from the trolley to the pole. These pull-offs, as usual, are provided with turn-buckles, so that the pull-offs can be varied at length, adjusting the trolley to the proper curve. The other general method is the flexible method, where the trolley wire is connected to a heavy span wire by means of pull-offs, and this method has the advantage of equalizing the strains on the different pull-offs, and tending naturally to hold the trolley wire to a curve.

Figure 1. Load factor for each day, obtained by dividing the total daily output by the total capacity.

Figure 2. Output for each day in both alternating current and direct current.

H. M. BEUGLER.

A 3

Exhibition Department

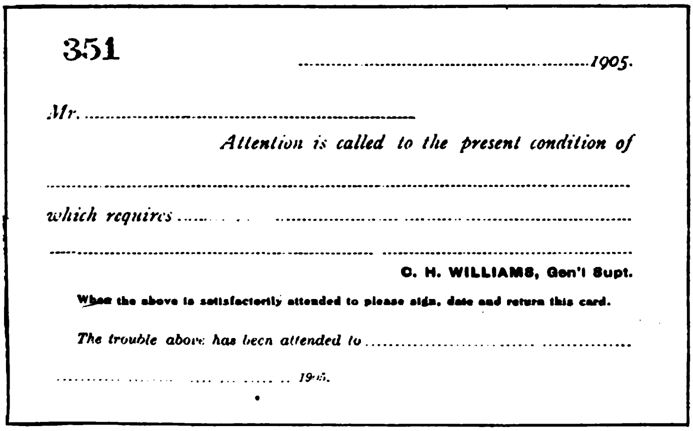
While the maintenance of an exhibition department by electric lighting companies is not a new idea, still it has not been universally adopted. The Boston Edison Company has maintained one for five years, and finds it a very satisfactory method of advertising, not only for the company but for the various exhibitors. Properly managed, it undoubtedly proves a good investment.

La Rue Vredenburgh, Boston, Mass.

A 4

Apparatus Inspection Report

Each piece of electrical apparatus in each station is charged directly to one man; whether he has the handling of it all the time or not, he is personally responsible for its condition at all times. Once a week a report is submitted on every piece of apparatus. In each station, in a conspicuous place, the several pieces of machinery, boards, etc., are listed, and set opposite is the name of the man who has the responsibility of keeping it in shape. When the report shows adverse criticism an order is made out as shown by the accompanying sample. These are made in triplicate—the original kept on file at the office, the others sent to the man whose duty it is to rectify the trouble. When the trouble has been attended to he signs and returns the slip, keeping the third one himself. In this way a record is had when orders are given, and there is no chance of a man's claiming that the instructions were not received. It further brings to light the fact that work is not properly attended to, should the same work be reported several times. Besides this, it places a man in a position where



351 ....*1905.*

Mr. ....

Attention is called to the present condition of

....

which requires ....

....

C. H. WILLIAMS, Gen'l Supt.

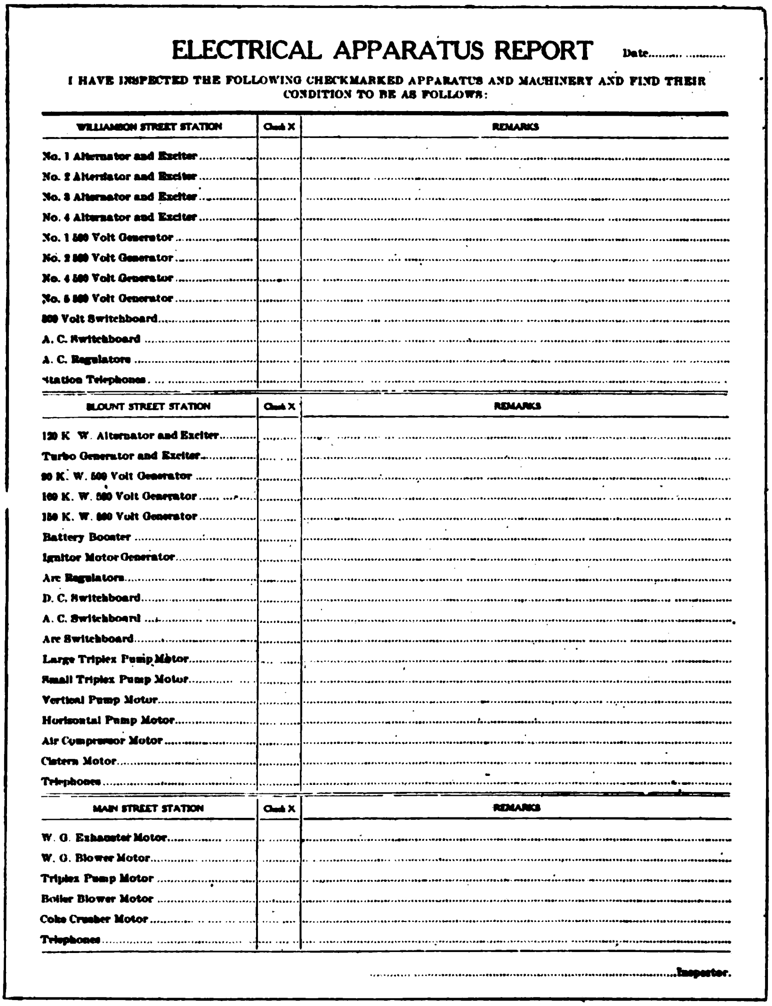
When the above is satisfactorily attended to please sign, date and return this card.

The trouble above has been attended to ....

.... *1905.*

Fig. 1

personal pride will prompt him to do a great deal more to keep his particular apparatus in shape, as each visitor to the engine-room can see which machines are being cared for by certain men.



ELECTRICAL APPARATUS REPORT

Date..................

I HAVE INSPECTED THE FOLLOWING CHECKMARKED APPARATUS AND MACHINERY AND FIND THEIR CONDITION TO BE AS FOLLOWS:

WILLIAMSON STREET STATION	Check X	REMARKS
No. 1 Alternator and Exciter		
No. 2 Alterdator and Exciter		
No. 3 Alternator and Exciter		
No. 4 Alternator and Exciter		
No. 1 500 Volt Generator		
No. 2 500 Volt Generator		
No. 4 500 Volt Generator		
No. 5 500 Volt Generator		
500 Volt Switchboard		
A. C. Switchboard		
A. C. Regulators		
Station Telephones		

BLOUNT STREET STATION	Check X	REMARKS
120 K. W. Alternator and Exciter		
Turbo Generator and Exciter		
90 K. W. 500 Volt Generator		
100 K. W. 500 Volt Generator		
150 K. W. 500 Volt Generator		
Battery Booster		
Ignitor Motor Generator		
Arc Regulators		
D. C. Switchboard		
A. C. Switchboard		
Arc Switchboard		
Large Triplex Pump Motor		
Small Triplex Pump Motor		
Vertical Pump Motor		
Horisontal Pump Motor		
Air Compressor Motor		
Cistern Motor		
Telephones		

MAIN STREET STATION	Check X	REMARKS
W. G. Exhauster Motor		
W. G. Blower Motor		
Triplex Pump Motor		
Boiler Blower Motor		
Coke Crusher Motor		
Telephones		

....Inspector.

FIG. 2

There is practically no expense incurred in carrying out the scheme, and it would appear that "Repairs Electrical Apparatus" will decrease materially, due to the periodic inspection and overhauling. The work orders are very handy to insure having the work done promptly, as the two dates—that of issuing the order and that of executing the work—tell the whole story.

C. H. Williams.

A 5

Order for Inside Wiring

For Plants Operating Under a Whole or Partial Flat-Rate Plan

For a long time we were puzzled to know where to file reports of work, also reports of lights cut in or out, until we adopted the following plan:

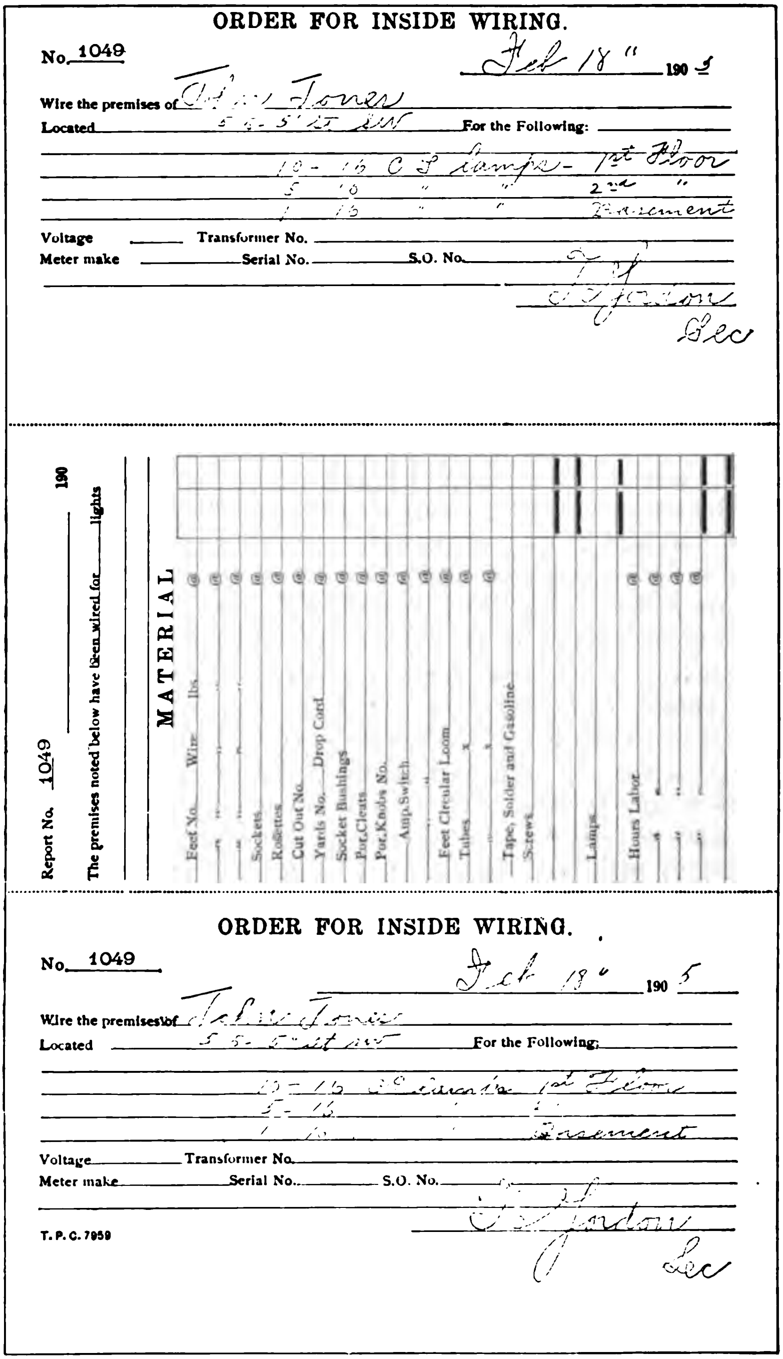
Before a house is wired the party desiring the service makes application to us, and he is required to fill in a regular blank for that purpose. After this is done a wiring order is made like the one enclosed, and as soon as the work is done and the proper return made the application and the cost of the wiring report is filed in an envelope, on the front of which the street and number are given, and whenever afterwards there is any change made in the number of lights in that particular house the report of the cut-in or cut-out is filed in the same envelope; in fact, everything pertaining to the wiring or lighting of that particular place is filed in that envelope. We keep an envelope with every house or place of business in which we have any wires, keeping each street by itself, and have the street numbers running consecutively, so that reference can be made without any trouble or loss of time.

The order, as you will see, is made out in triplicate; No. 1 is kept on file in the office, and the file on which this is kept shows us at any time just what orders are not completed.

Forms Nos. 2 and 3 go to our foreman, and the material used on the job is entered each day until the work is completed, at which time he returns No. 2 to the office and keeps No 3 on his file. He, of course, uses carbon paper in making up his daily charge against the job.

If it is not desired to retain one at the foreman's headquarters, No. 3 could be used for reporting the cost of the service, after making a change in the reading of the form.

T. C. Gordon, Little Falls, Minn.



ORDER FOR INSIDE WIRING.

No. 1049 Feb 18" 1905

Wire the premises of John Jones

Located 55-5th St. NW For the Following:

10-16 C P lamps - 1st Floor

5 16 " " 2nd "

1 16 " " Basement

Voltage ______ Transformer No. ______

Meter make ______ Serial No. ______ S.O. No. ______

T. J. Jordan

Sec

Report No. 1049 ______ 190

The premises noted below have been wired for ______ lights

MATERIAL

Feet No. ___ Wire ___ lbs.

" " "

" " "

Sockets

Rosettes

Cut Out No.

Yards No. ___ Drop Cord

Socket Bushings

Por. Cleats

Por. Knobs No.

Amp. Switch

" "

Feet Circular Loom

Tubes x

" x

Tape, Solder and Gasoline

Screws

Lamps

Hours Labor

"

"

"

ORDER FOR INSIDE WIRING.

No. 1049 Feb 18" 1905

Wire the premises of John Jones

Located 55-5th st nw For the Following:

10-16 C P lamps 1st Floor

5-16 " "

1 16 " Basement

Voltage ______ Transformer No. ______

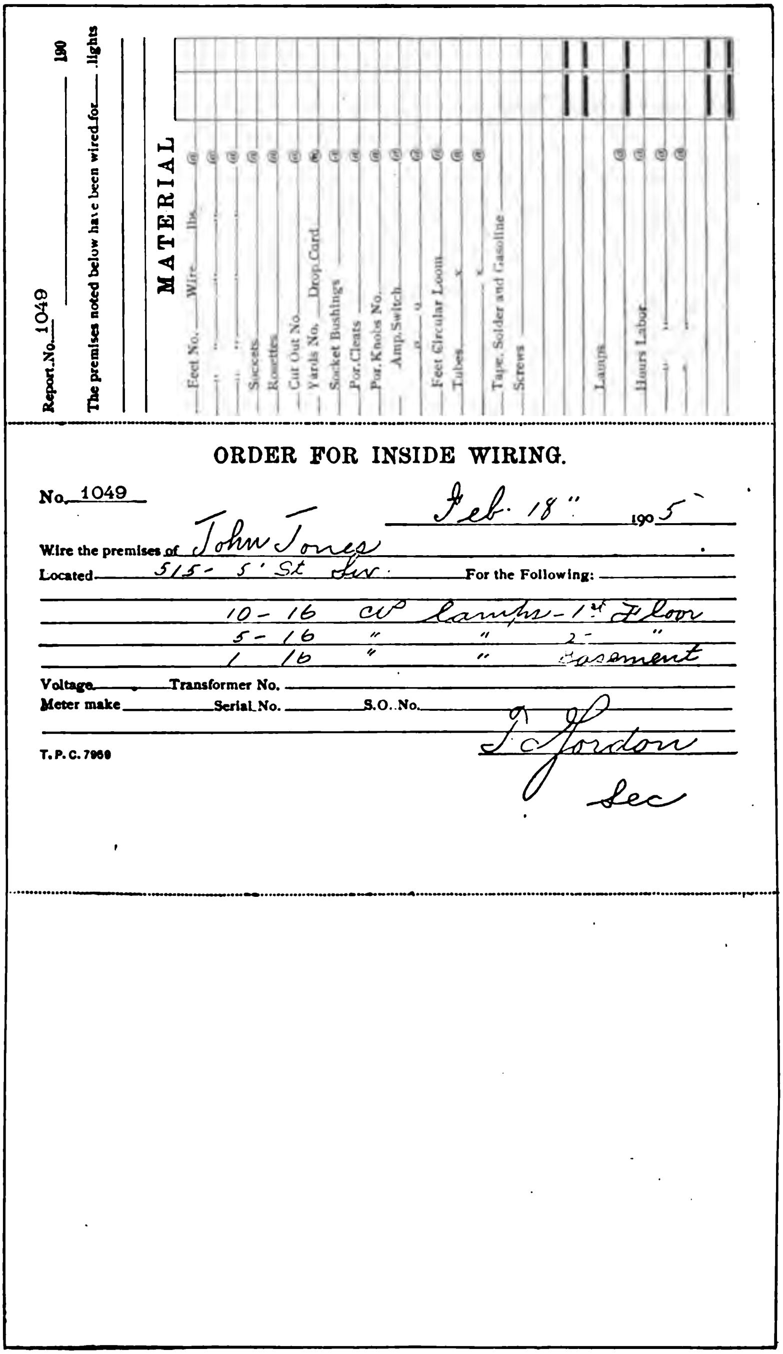
Meter make ______ Serial No. ______ S.O. No. ______

T. P. C. 7959

T. J. Jordan

Sec

FIG. 1



Report No. 1049 ____ 190

The premises noted below have been wired for ____ lights

MATERIAL

Feet No. ____ Wire ____ lbs. @
" " ____ @
" " ____ @
Sockets ____ @
Rosettes ____ @
Cut Out No. ____ @
Yards No. ____ Drop Card ____ @
Socket Bushings ____ @
Por. Cleats ____ @
Por. Knobs No. ____ @
Amp. Switch ____ @
" " ____ @
Feet Circular Loom ____ @
Tubes ____ x ____ @
" ____ x ____ @
Tape, Solder and Gasoline ____
Screws ____
Lamps ____ @
Hours Labor ____ @
" " ____ @
" " ____ @

ORDER FOR INSIDE WIRING.

No. 1049 Feb. 18" 1905

Wire the premises of John Jones

Located 515 - 5' St Sw. For the Following:

10 - 16 cp lamps - 1st Floor
5 - 16 " " 2nd "
1 16 " " basement

Voltage ____ Transformer No. ____
Meter make ____ Serial No. ____ S.O. No. ____

T. P. C. 7969

J. C. Jordan
Sec

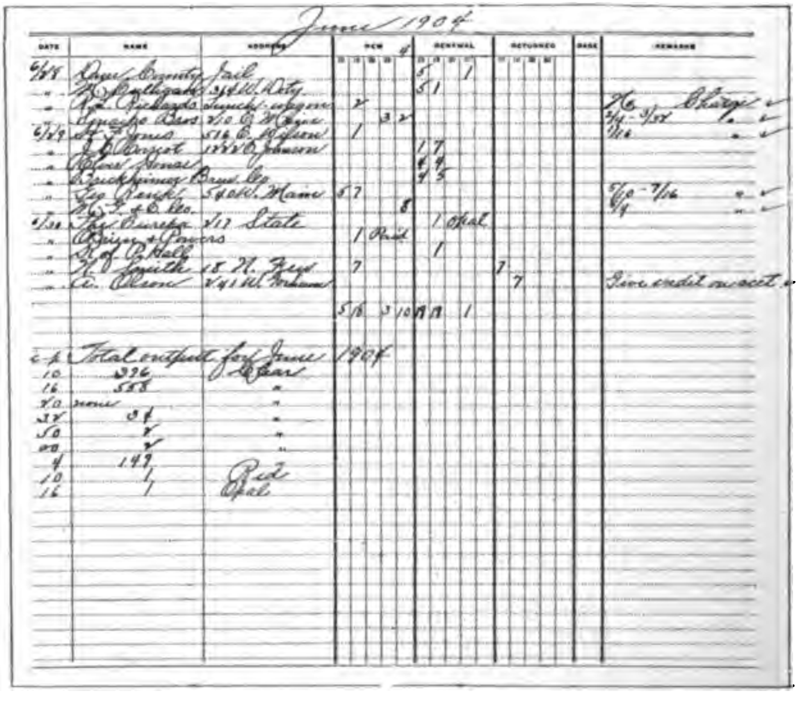
Fig. 2—Reverse of Fig. 1

A 6

A Convenient Method of Keeping a Monthly Record of Incandescent Lamps

To the central station making free lamp renewals the following method of keeping a monthly record of the incandescent lamp output will be found extremely simple, and will, in a short time after having been put in practice, demonstrate its usefulness.

This ledger is kept by the man having charge of lamp renewals and installations, and is submitted weekly to the one having charge of petty ledger accounts, who in turn renders bills according to charges made therein.



June 1904

DATE	NAME	ADDRESS	NEW	RENEWAL	RETURNED	BASE	REMARKS
6/18	Dane County	Jail		5 1			
"	H. [illegible]	348 W. Doty		5 1			
"	R. L. Richards	Lunch wagon	2				No Charge ✓
"	Ignatio Bros	210 E. Main	3 2				3/4-3/24 " ✓
6/19	H. Jones	516 E. Wilson	1				3/16 " ✓
"	J. [illegible]	1828 E. Johnson		1 7			
"	[illegible]			4 4			
"	Breckheimer Brew. Co.			4 5			
"	Geo. Rauch	540 W. Main	5 7				5/10-7/16 " ✓
"	M. G. & E. Co.		8				6/4 " ✓
6/20	The Eureka	417 State		1 Opal			
"	Brien & Powers		1 Red				
"	K. of P. Hall			1			
"	H. Smith	18 N. Fry	7		7		
"	A. Olson	241 W. Johnson			7		Give credit on acct. ✓
			5 16 3 10	18 18 1			
c.p.	Total output	for June	1904				
10	396	Clear					
16	558	"					
20	none	"					
32	34	"					
50	2	"					
100	2	"					
4	149	"					
10	1	Red					
16	1	Opal					

Very frequently consumers present disputed bills, which have been rendered for lamps received by them the previous month. By having the lamp ledger at hand the number of lamps the consumer received and the conditions under which they were issued may be quickly determined. This record, if accurately kept, will frequently bring about surprising results in regard to the actual number of lamps issued in a year's time. By determining monthly the number, kind and candle-power of lamps delivered, and the result entered on a separate page, the yearly output may easily be determined at the end of that time by adding the different monthly outputs. Districts having proportionately higher lamp renewals will quickly be noticed on the lamp ledger, and steps may be taken toward remedying the trouble, such as changing transformer ratios, etc. Lamps are issued under four conditions, viz.: New lamps for which consumers are to be charged, duplicate renewals, lamps returned, for which consumer is to be credited, and exchanging lamps of one candle-power for that of another.

It is advisable to foot up the total on each page as soon as it has been completed. This will avoid a great deal of tedious work at the end of the month.

The accompanying cut shows fac-simile of a page torn from a lamp ledger as herein described.

Robt. J. Nickles, Madison, Wis.

A 7

Pasting Stickers on Bills

Each month, in sending out our bills, we paste on the lower left-hand corner a sticker containing a suggestion as to various appliances that we have for sale, or calling attention to various matters of general interest to our customers. Upon the back of the bill-head we also have printed matters of general interest referring to our business. The following are examples:

WIRING . . .

We would suggest to those contemplating wiring their premises for Electric Light or Power that they communicate with us before contracting for same, so that we may give them the benefit of our experience and advise the proper method and arrangement of wiring. No charge will be made for this service.

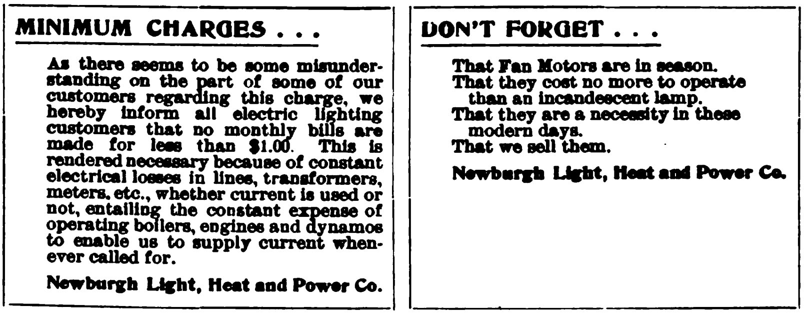
Newburgh Light, Heat and Power Co.

WE WOULD CONSIDER . . .

It a favor if our customers would advise us of any defects in our system. It is our intention and desire to give the best possible service. We are always glad to receive just criticism.

Newburgh Light, Heat and Power Co.

Stickers



MINIMUM CHARGES . . .

As there seems to be some misunderstanding on the part of some of our customers regarding this charge, we hereby inform all electric lighting customers that no monthly bills are made for less than $1.00. This is rendered necessary because of constant electrical losses in lines, transformers, meters, etc., whether current is used or not, entailing the constant expense of operating boilers, engines and dynamos to enable us to supply current whenever called for.

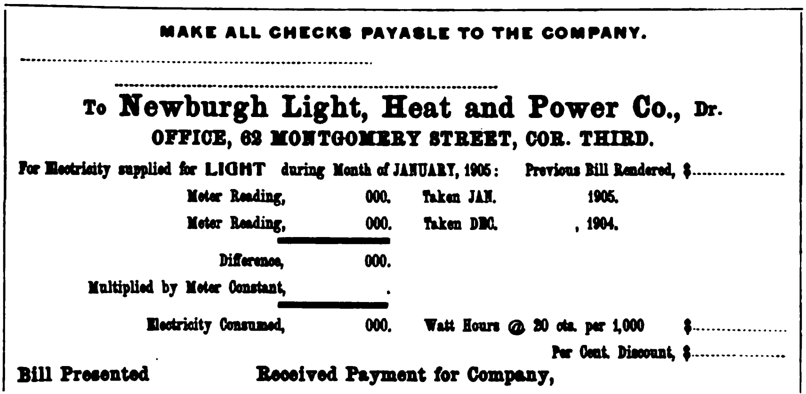
Newburgh Light, Heat and Power Co.

DON'T FORGET . . .

That Fan Motors are in season.
That they cost no more to operate than an incandescent lamp.
That they are a necessity in these modern days.
That we sell them.

Newburgh Light, Heat and Power Co.

STICKERS

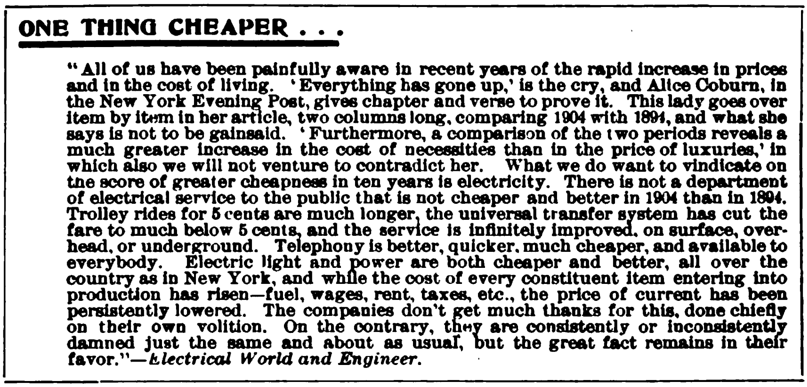


MAKE ALL CHECKS PAYABLE TO THE COMPANY.

To **Newburgh Light, Heat and Power Co.,** Dr.
OFFICE, 62 MONTGOMERY STREET, COR. THIRD.

For Electricity supplied for LIGHT during Month of JANUARY, 1905: Previous Bill Rendered, $..................
Meter Reading, 000. Taken JAN. 1905.
Meter Reading, 000. Taken DEC. , 1904.
Difference, 000.
Multiplied by Meter Constant, .
Electricity Consumed, 000. Watt Hours @ 20 cts. per 1,000 $..................
Per Cent. Discount, $..................
Bill Presented Received Payment for Company,

FACE OF BILL



ONE THING CHEAPER . . .

"All of us have been painfully aware in recent years of the rapid increase in prices and in the cost of living. 'Everything has gone up,' is the cry, and Alice Coburn, in the New York Evening Post, gives chapter and verse to prove it. This lady goes over item by item in her article, two columns long, comparing 1904 with 1894, and what she says is not to be gainsaid. 'Furthermore, a comparison of the two periods reveals a much greater increase in the cost of necessities than in the price of luxuries,' in which also we will not venture to contradict her. What we do want to vindicate on the score of greater cheapness in ten years is electricity. There is not a department of electrical service to the public that is not cheaper and better in 1904 than in 1894. Trolley rides for 5 cents are much longer, the universal transfer system has cut the fare to much below 5 cents, and the service is infinitely improved, on surface, overhead, or underground. Telephony is better, quicker, much cheaper, and available to everybody. Electric light and power are both cheaper and better, all over the country as in New York, and while the cost of every constituent item entering into production has risen—fuel, wages, rent, taxes, etc., the price of current has been persistently lowered. The companies don't get much thanks for this, done chiefly on their own volition. On the contrary, they are consistently or inconsistently damned just the same and about as usual, but the great fact remains in their favor."—*Electrical World and Engineer.*

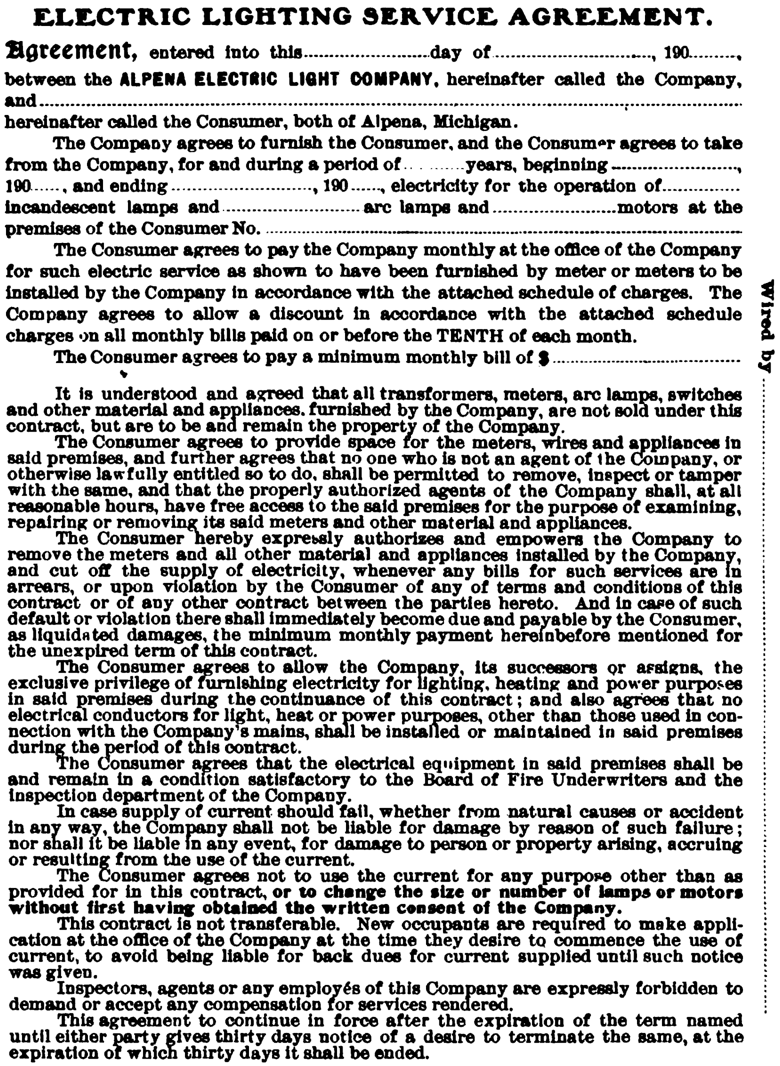
REVERSE OF BILL

I am aware that this "wrinkle" is in use by some companies, but I know of others who have not heard of it but who may be interested in trying it. E. J. RICHARDS, Newburgh, N. Y.

A 8

Electric Lighting Service Agreement and Schedule of Rates

You will find below our contract and schedule of rates. In one the rate per 1000 watts is fixed by a sliding scale, lowering as the average hours used per light increase. This is designed to reach small customers who can afford but few lights and who



ELECTRIC LIGHTING SERVICE AGREEMENT.

Agreement, entered into this........................day of..............................., 190........,
between the **ALPENA ELECTRIC LIGHT COMPANY**, hereinafter called the Company,
and...
hereinafter called the Consumer, both of Alpena, Michigan.

The Company agrees to furnish the Consumer, and the Consumer agrees to take from the Company, for and during a period of..........years, beginning..........................., 190......, and ending............................, 190......, electricity for the operation of............... incandescent lamps and...........................arc lamps and.........................motors at the premises of the Consumer No. ....

The Consumer agrees to pay the Company monthly at the office of the Company for such electric service as shown to have been furnished by meter or meters to be installed by the Company in accordance with the attached schedule of charges. The Company agrees to allow a discount in accordance with the attached schedule charges on all monthly bills paid on or before the TENTH of each month.

The Consumer agrees to pay a minimum monthly bill of $.......................................

It is understood and agreed that all transformers, meters, arc lamps, switches and other material and appliances, furnished by the Company, are not sold under this contract, but are to be and remain the property of the Company.

The Consumer agrees to provide space for the meters, wires and appliances in said premises, and further agrees that no one who is not an agent of the Company, or otherwise lawfully entitled so to do, shall be permitted to remove, inspect or tamper with the same, and that the properly authorized agents of the Company shall, at all reasonable hours, have free access to the said premises for the purpose of examining, repairing or removing its said meters and other material and appliances.

The Consumer hereby expressly authorizes and empowers the Company to remove the meters and all other material and appliances installed by the Company, and cut off the supply of electricity, whenever any bills for such services are in arrears, or upon violation by the Consumer of any of terms and conditions of this contract or of any other contract between the parties hereto. And in case of such default or violation there shall immediately become due and payable by the Consumer, as liquidated damages, the minimum monthly payment hereinbefore mentioned for the unexpired term of this contract.

The Consumer agrees to allow the Company, its successors or assigns, the exclusive privilege of furnishing electricity for lighting, heating and power purposes in said premises during the continuance of this contract; and also agrees that no electrical conductors for light, heat or power purposes, other than those used in connection with the Company's mains, shall be installed or maintained in said premises during the period of this contract.

The Consumer agrees that the electrical equipment in said premises shall be and remain in a condition satisfactory to the Board of Fire Underwriters and the inspection department of the Company.

In case supply of current should fail, whether from natural causes or accident in any way, the Company shall not be liable for damage by reason of such failure; nor shall it be liable in any event, for damage to person or property arising, accruing or resulting from the use of the current.

The Consumer agrees not to use the current for any purpose other than as provided for in this contract, **or to change the size or number of lamps or motors without first having obtained the written consent of the Company.**

This contract is not transferable. New occupants are required to make application at the office of the Company at the time they desire to commence the use of current, to avoid being liable for back dues for current supplied until such notice was given.

Inspectors, agents or any employés of this Company are expressly forbidden to demand or accept any compensation for services rendered.

This agreement to continue in force after the expiration of the term named until either party gives thirty days notice of a desire to terminate the same, at the expiration of which thirty days it shall be ended.

Wired by..

This Contract shall not be considered binding until accepted by the General Manager of the Company.

ALPENA ELECTRIC LIGHT COMPANY,

By..

Accepted this..**day**

of...**19**........

....

Consumer.

....

General Manager.

ALPENA ELECTRIC LIGHT COMPANY

SCHEDULE OF METER RATES FOR COMMERCIAL LIGHTING

Commercial consumers are entitled to settle according to the following rates should they for any month be found to be less than the regular schedule hereto attached

WHEN	GROSS	AMOUNT	OF	MONTHLY	BILL	IS	$10	THE	RATE	SHALL	BE	SAME	AS	1	HOUR	DAILY	USE
"	"	"	"	"	"	"	15	"	"	"	"	"	"	1½	"	"	"
"	"	"	"	"	"	"	20	"	"	"	"	"	"	2	"	"	"
"	"	"	"	"	"	"	25	"	"	"	"	"	"	2½	"	"	"
"	"	"	"	"	"	"	30	"	"	"	"	"	"	3	"	"	"
"	"	"	"	"	"	"	35	"	"	"	"	"	"	3½	"	"	"
"	"	"	"	"	"	"	40	"	"	"	"	"	"	4	"	"	"
"	"	"	"	"	"	"	45	"	"	"	"	"	"	4½	"	"	"
"	"	"	"	"	"	"	50	"	"	"	"	"	"	5	"	"	"
"	"	"	"	"	"	"	55	"	"	"	"	"	"	5½	"	"	"
"	"	"	"	"	"	"	60 or over		"	"	"	"	"	6	"	"	"

NOTE.—For regular schedule, see page 111.

use them more hours, also saloons, restaurants, etc., where lights are used more hours. By the other the rate is fixed by gross amount of bill. This is designed to catch stores, theatres, etc., that have a large number of lights which are used only a short time, but where a lower rate must be given to get the business. Like every other corporation, we are after business and wish to get all of it at living rates. We are interested in the National Association, and will always gladly contribute anything we can to increase the interest in and efficiency of the organization.

This contract is printed on a sheet seven inches by eight and one-half and folds once, like a voucher, being indorsed on the back. The schedules are about half the size, and are attached to the contract as stickers.

GEORGE P. SMITH, Alpena, Mich.

A 9

A Handy and Efficient Method of Showing on a Wall Map the Boundaries of Incandescent Feeders and Sizes and Locations of Transformers on Same

The method employed by the Denver Gas and Electric Company is briefly explained in the following:

A map representing 500 feet to the inch is pasted on a frame made of kiln-dried pine boards, which is fastened to the wall. The feeder boundaries are shown by tacking on silk cord. The primary and secondary wires are shown by two colors of ink. The location of the transformers is shown by fancy-headed toilet pins, cut off and driven into the map on the primary where the transformer is located. The size of the transformer is shown by using different sized and colored pins. By using these pins they may be shifted on the map as the transformers are shifted or changed on the feeders.

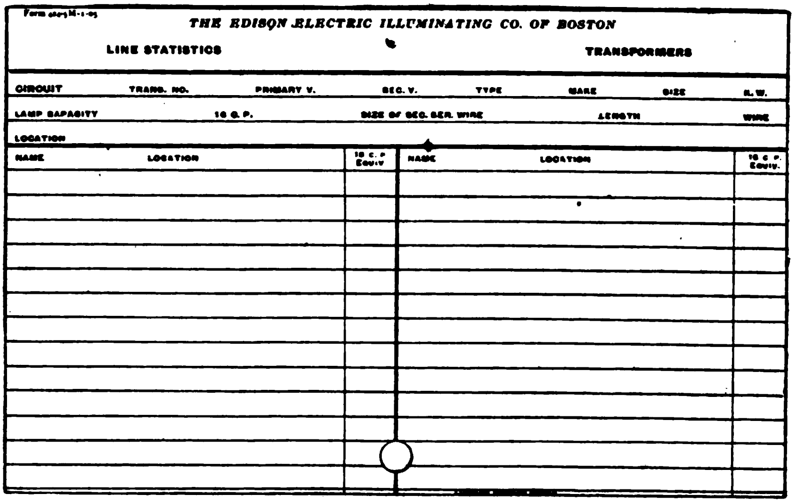
As a map of this kind will be quite large, depending on the scale to which it is drawn and the size of the territory covered, it is difficult to obtain a frame that will not shrink, thus causing the map to crack. A manufactured composition board will not warp or shrink, but must be soft enough to receive the pins. If boards are used they should be thoroughly kiln-dried and well seasoned.

E. A. TAYLOR, Denver, Colo.

A 10

Line Statistics and Transformer Records

It may be of interest to illustrate a method of keeping record of customers, connected load and services connected to individual transformers in an overhead or underground system. One side of the card is reserved for names of customers and connected load, and on the reverse side a sketch is made to scale giving details of attachments of wires to poles or buildings as made in serving customers from the particular transformer under consideration. Where secondary networks exist supplied by transformers in multiple which cover so large a territory that they can



Form [illegible] M-1-05

THE EDISON ELECTRIC ILLUMINATING CO. OF BOSTON

LINE STATISTICS TRANSFORMERS

CIRCUIT TRANS. NO. PRIMARY V. SEC. V. TYPE MAKE SIZE K. W.

LAMP CAPACITY 16 C. P. SIZE OF SEC. SER. WIRE LENGTH WIRE

LOCATION

NAME	LOCATION	16 C. P. Equiv	NAME	LOCATION	16 C. P. Equiv.

FIG. 1—FACE OF CARD

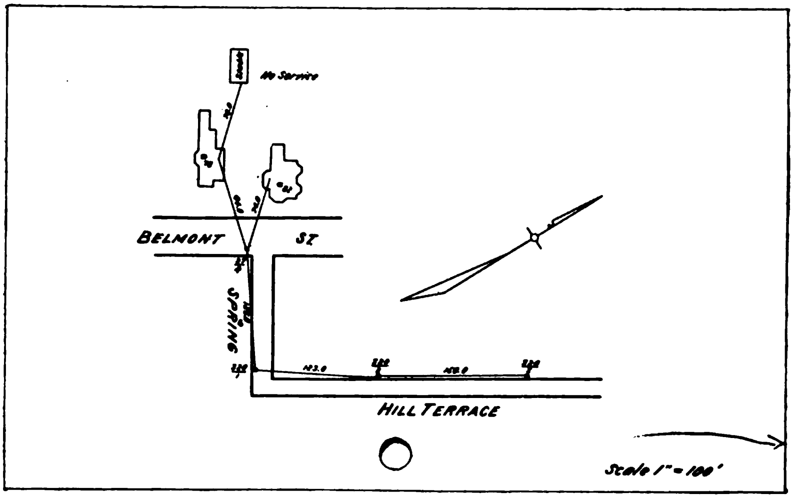


FIG. 2—REVERSE OF CARD

not be shown on one card additional cards are used, and the plan of the whole network is shown on the combined cards.

A sample card is enclosed. LEONARD L. ELDEN.

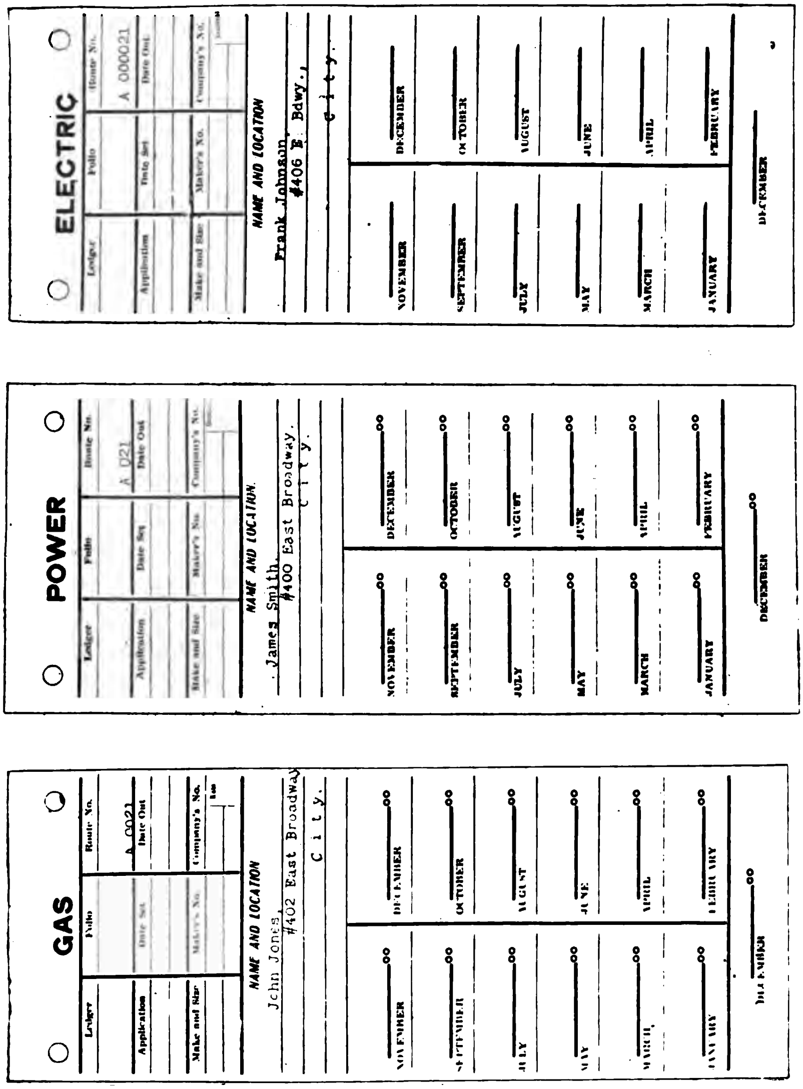
A 11

A Meter-Reading Method

This company operates the gas, electric light and power business of Albuquerque, and realizing that the old method of reading meters from meter books was taking entirely too much time in making it necessary to send a gas-meter reader and electric-light-meter reader over the same ground, we discarded the meter books entirely. We use a form of meter slip (samples of which I herewith enclose) printed on thin, stout bond paper. You will note that we use different colors for gas, power and electric. We have a blank printed giving ledger, folio, route, number, application, date, date set, date out, make and size, maker's number, company's number, constant, name and location and blanks for the year's business by months. At the bottom of the sheet is the December reading of the previous year.

The route of the meter reader is made up in bundles of one day's readings and numbered from one up in consecutive order. Each bundle is known by letters, as A, B, C, D, etc. Should a customer move from one part of town to another, the letter is changed on the meter slip so as to be in rotation for reading, the idea being that after the slips are distributed in numeral order on each route the next number in the reader's file should take him to the next meter location, so that he will not double back and forth to hunt for a certain name and location.

Whenever there are new installations interspersed on the route the number of the meter slip for that location would appear as a cipher prefixed to the previous number; e. g., John Smith has an electric service installed, or, for that matter, gas or power (it makes no difference), next door to John Jones, whose number we will say is 32. This new consumer's number would therefore take the cipher thus, 0-33, which shows the meter reader that he should read this meter before going to the original number 33. If the meter reader finds any numbers missing in his route file he naturally assumes that the service has been discontinued. At the end of the day's work the meter reader turns his finished file in to the bookkeeper, who distributes it in alphabetical order for his ledger, making all deductions. Should there be any great discrepancies either over or under, these slips are placed with the "not at homes" and other slips for which it has been impossible to get readings, for various reasons. They are put in a separate bunch, and after the regular work is finished are again placed in route form, and another trial is made. We make three attempts



ELECTRIC

Ledger | Folio | Route No.
Application | Date Set | Date Out
Make and Size | Maker's No. | Company's No.
A 000021

NAME AND LOCATION
Frank Johnson
#406 E. Bdwy.
City.

DECEMBER, OCTOBER, AUGUST, JUNE, APRIL, FEBRUARY, DECEMBER
NOVEMBER, SEPTEMBER, JULY, MAY, MARCH, JANUARY

POWER

Ledger | Folio | Route No.
Application | Date Set | Date Out
Make and Size | Maker's No. | Company's No.
A 021

NAME AND LOCATION
James Smith
#400 East Broadway.
City.

DECEMBER, OCTOBER, AUGUST, JUNE, APRIL, FEBRUARY, DECEMBER
NOVEMBER, SEPTEMBER, JULY, MAY, MARCH, JANUARY

GAS

Ledger | Folio | Route No.
Application | Date Set | Date Out
Make and Size | Maker's No. | Company's No.
A 0021

NAME AND LOCATION
John Jones
#402 East Broadway
City.

DECEMBER, OCTOBER, AUGUST, JUNE, APRIL, FEBRUARY, DECEMBER
NOVEMBER, SEPTEMBER, JULY, MAY, MARCH, JANUARY

METER-READING CARDS

to get in all meter readings, and if it happens that we can not get a reading after the third trial "not at home" is simply entered on the meter slip in place of the reading and the minimum charge carried to the ledger.

We have found this manner of reading meters very satisfactory; in fact, it makes it possible for one man to read as many meters in one day as four men did under the old way; and it is much more satisfactory, as we all agree that the average family takes it as almost an open insult for a man to ring the door-bell and in ever so polite a manner ask to "read the meter." It is best to send as few men out on this work as possible. Besides, when these meter slips are properly routed in the office, ready for the meter reader so that he does not have to study names and locations and where he is going to end his day's work, we find the greater portion of his work is done; it is not so much the number of meters as how to get to them.

Each route is made up of a portion of business installations so that the reader can begin his work early in the morning, and by the time he gets to the residence portion of his route breakfast is over in the private families, and they are in a measure ready to admit the "octopus" representative, as they term it.

We have also insisted that the electric-light contractors must arrange the meter loops so that it will not be necessary to carry a step-ladder, but where they may be conveniently read from the floor. We find this convenient both for ourselves and for our customers.

We find that where the consumers are taught how to read their own meters, and where the meters are accessible, so that consumers can read them from time to time, we do not have complaints about excessive bills.

E. C. ALLEN, Albuquerque, N. M.

A 12

A Method of Charging

It has occurred to me that possibly a publication of our rate sheet may prove of interest to some of the members of our association.

This rate sheet is issued as a folder, three and a half by six inches in size.

The four pages are as follows:

EDISON

Light .·. Heat .·. Power

Edison Electric Illuminating Co.
Topeka, Kansas

722 Van Brunt St. Phone 369

PAGE 1

RATES

For Arc and Incandescent Lighting

Rates per 1,000 Watt Hours	With Guaranteed Earnings per Month per 16-cp Lamp Connected	Equivalent to Approximately Burning Installation Hours per Day
10 cents	30 cents	2 hours
8 cents	36 cents	3 hours
6 cents	45 cents	5 hours
5 cents	60 cents	8 hours

The basis of figuring the installation connected is as follows:

Each 6-cp lamp equals 25 watts.
Each 10-cp lamp equals 36 watts.
Each 16-cp lamp equals 50 watts.
Each 24-cp lamp equals 75 watts.
Each 32-cp lamp equals 100 watts.
Each 25-cp Meridian lamp equals 60 watts.
Each 50-cp Meridian lamp equals 120 watts.
Each standard arc lamp equals 500 watts.

The total watts used by total lamps connected divided by 50 watts equals the 16-cp lamps connected.

PAGE 2

EXAMPLE

An installation consisting of

2 6-cp lamps @ 25 watts equals 50 watts
9 16-cp " " 50 " " 450 "
2 Arc " " 500 " " 1,000 "
1,500 " ÷ 50 = 30 16-cp lamps.

The above installation burning 3 hours per day for 30 days would consume 135,000 watt-hours, at 8 cent rate equals $10.80.

A guarantee of 36 cents per 16-cp lamp per month equals $10.80.

Same installation burning 4 hours per day for 30 days would consume 180,000 watt-hours, at 8 cent rate equals $14.40.

PAGE 3

PHILOSOPHIC BITS

Why economize with light any more than with cheerfulness? Neither costs as much in the long run as gloom and irritability.

An electric light bears the same relation to a room that a smile does to a human being.

Using electric light is one way the modern merchant has of advertising.

If you are depressed, touch a button and have a few volts of cheerfulness. It will only cost a few cents.

With plenty of electric lights you can even see an argument better.

An electric light is one expression of true success.

EDISON CO.

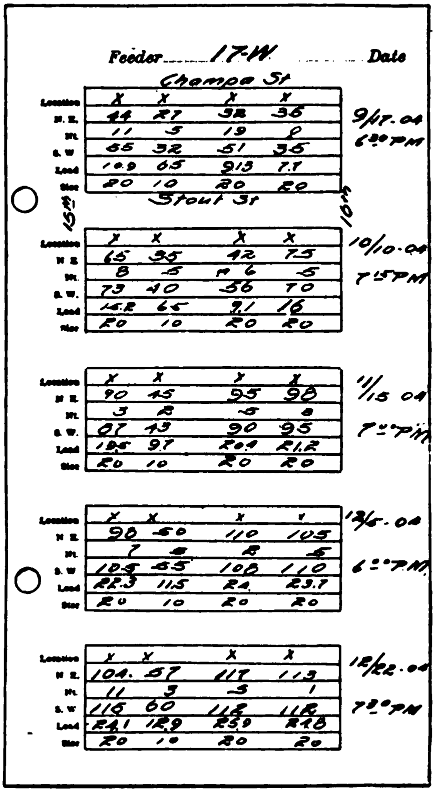
PAGE 4

This plan of charging, or rather of contracting, has proved especially successful in Topeka in obtaining long-hour users as customers. C. R. MAUNSELL, Topeka, Kansas.

A 13

Record of Transformer Location

We have a very satisfactory way of keeping a record of our transformers, as to their location, size of load and balancing of the load. We use a loose-leaf book with pages as per sample. Each rectangle represents a block, which can be designated as shown. All our secondaries are connected in the same way; the north is connected to the east and the south to the west. In the line (location) we place a cross (X) to show at what part of the alley the transformer is. The next line, N.E., is the load in amperes on that side of the system. The line S.W. is the load in amperes on the other side of the system. Nt. is the load in amperes in the neutral.



Feeder 17-W Date

Champa St

Location	X	X	X	X	
N.E.	44	27	32	35	9/17.04
Nt.	11	5	19	2	6^{30} PM
S.W.	65	32	51	35	
Load	10.9	6.5	9.13	7.1	
Size	20	10	20	20	

Stout St

15th

16th

Location	X	X	X	X	10/10.04
N.E.	65	35	42	75	
Nt.	8	5	6	5	7^{15} PM
S.W.	73	40	36	70	
Load	14.2	6.5	9.1	16	
Size	20	10	20	20	

Location	X	X	X	X	
N.E.	90	45	95	98	11/15 04
Nt.	3	2	5	8	
S.W.	97	43	90	95	7^{00} PM
Load	19.5	9.7	20.4	21.2	
Size	20	10	20	20	

Location	X	X	X	X	12/5.04
N.E.	98	50	110	105	
Nt.	7	5	2	5	
S.W.	105	55	108	110	6^{00} P.M.
Load	22.3	11.5	24	23.7	
Size	20	10	20	20	

Location	X	X	X	X	
N.E.	104	57	117	113	12/22.04
Nt.	11	3	5	1	
S.W.	116	60	112	112	7^{00} PM
Load	24.1	12.9	25.9	24.8	
Size	20	10	20	20	

Page from Transformer Record

The line load is the total load in kilowatts on the transformer, and the line size is for the size of the transformer.

G. F. WILLARD Denver, Colo.

B

CONSUMERS' INSTALLATIONS AND SERVICES

B 1

Locating Grounds in Buildings

A handy device for locating the points where wires are grounded in buildings was made by taking a U-shaped yoke of iron and winding on it a coil of very fine wire and connecting this coil to a telephone receiver. When the yoke is brought in proximity to a wire carrying a current a buzzing will be heard in the telephone receiver, and grounds within the walls of a building can be located when carrying a current by moving the yoke along the wall. The method of locating a ground is as follows:

All the lights are turned off and the main feed tested; if there is a meter, care must be taken to get beyond the meter, as the current taken by the potential coil is sufficient to make the receiver buzz. If a buzzing is heard it can be traced to one of the branches, and this can be followed along the walls until a point is reached where the buzzing ceases or is diminished. This is the point where the current is leaving the conductor, or the grounded point. This apparatus works on both alternating and direct currents, but better on the former.

J. F. DOSTAL, Denver, Colo.

B 2

Using 50-Cp Nernst Lamps on a Direct-Current System

When the Nernst lamp was first put on the market I bought two single-glower, 220-volt lamps. I did not know that they were made for alternating current only. I very soon found that the glowers burned off the second or third time the current was turned on. I noticed that the glower always broke off close to the end where it was cemented to the platinum wire. As an experiment I wrapped the platinum wire around the broken end of the glower, about three turns, leaving the ball of cement on the end of the platinum wire, taking great care to squeeze this ball close in to the glower, to take the greatest part of the heat from the glower. After splicing the glowers in this way I have succeeded in burning lamps of this type on direct current about 600 to 800 hours. The scheme, however, is not a commercial success, and I do not advise that it be patented.

E. A. Aspnes, Montevideo, Minn.

B 3

Flicker Interrupter

A device, which may be called a "flicker interrupter," is proposed for use in connection with the demand system of charging, where it is impracticable or undesirable to install a demand meter. The instrument serves to interrupt the customer's service when the proper demand is exceeded.

This device is simply an electro-magnetic solenoid with a core which is extended downwards to form a plunger. This plunger enters into a steel cup containing mercury. The instrument is connected to one side of the customer's wiring at the service, one connection being made to the steel cup and the other (flexible) to the plunger.

When the customer's demand is normal, the plunger remains in the mercury, and the circuit is unbroken. If, however, the demand goes above the amount for which the instrument is set, the plunger vibrates in and out of the mercury, causing continuous interruption of the circuit. These interruptions will continue until the excess demand is cut out of the circuit.

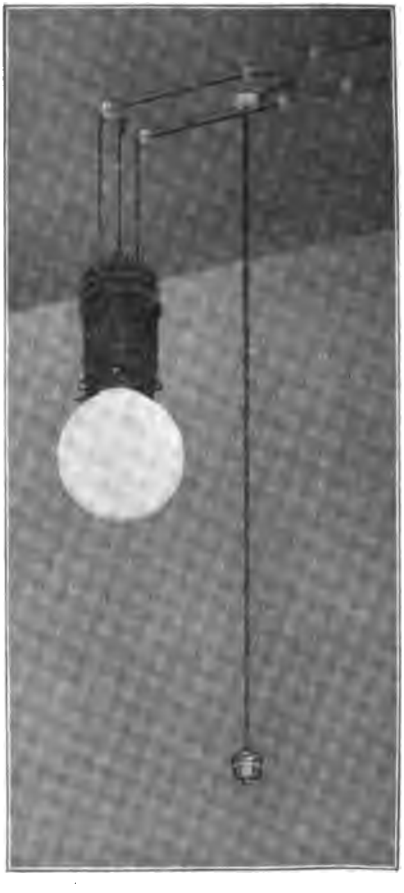
Leonard L. Elden, E. E. P. Co., Boston, Mass.

B 4

New Pendant Switch Device For Any Kind of Electric Light

The pendant switch has a definite field of usefulness in both arc and incandescent lighting. It has heretofore been applied to incandescent lighting almost exclusively, owing to the inspection rules, which do not permit the use of a single-pole switch on arc lamps.

The pendant switch is, however, capable of as broad application to arc as to incandescent lighting when the device herewith illustrated is used. A standard double-pole, 10-ampere snap switch is fitted with a nickel-plated canopy, which serves to admit the wires to the switch and supports it by a knot made in the cord inside the canopy. The four conductors forming the double-pole switch loop are neatly brought together under one braid, the whole presenting a very neat appearance. The cord is suspended from the ceiling on any of the usual forms of ceiling block.



In wholesale establishments and stores where it is impracticable to locate the switch near the arc lamp, it has heretofore been necessary to place all the switches in the cut-out cabinet at one end of the room. This makes it necessary for the salesman showing goods on a floor to go to the end of the room and switch on all the lamps which he will require in showing his customers the goods.

By the use of a double-pole pendant switch attached to each lamp he is able to show his goods effectively by turning the lamps on in each section as he comes to it, turning them off as he leaves the section.

Thus it becomes possible for many large establishments who have not felt able to pay the cost of electric lighting heretofore, to use the superior light of the arc lamp for showing all goods which do not appear to advantage under other light.

The device is also made for use with a single-pole switch, and in this form is adaptable to all uses to which pendant switches have been put heretofore.

The double-pole type may also be used on large incandescent clusters or fixtures, the single-pole type not being approved in Chicago for more than six 16-candle-power lamps.

The expense of installing the pendant switch is much less than that of wiring to a position on the wall, in most cases. With the type of switch here shown the cost of the canopy is but a fraction of the cost of the standard snap switch. The canopies made to fit the Hart switches are on sale in the supply department of the Chicago Edison Company.—Copied from *Electric City*, March, 1905.

C. H. STEWART, Chicago Edison Company.

B 5

Use of Alternating Current For Church Organ

Because of the unsatisfactory operation of a small motor-generator set, furnishing direct current at about 10 volts for operating the magnets on a large pipe organ, the Denver Gas and Electric Company installed an ordinary 600-watt transformer, which is working with perfect success. This transformer is the regular type H General Electric 2000-100-volt box taken from the company's lines. Its primaries are connected across 220 volts, giving 11-volt secondaries, furnishing current for 200 magnets controlling 2400 pipes.

Contrary to all expectation, there is no objectionable chattering of the magnets, and the church people are very much pleased with the entire scheme.

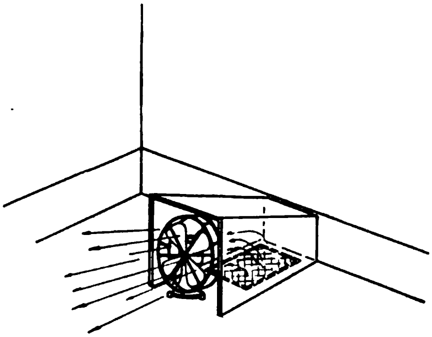
C. F. HAYWOOD, Denver, Colo.

B 6

Doubling the Efficiency of a Steam Radiator

ALSO OF AN EFFICIENT FURNACE REGISTER

There are a good many rooms in Chicago apartments where the radiator is either too small or the steam pressure too low to maintain a comfortable temperature in severe weather. If the tenant is enjoying the many advantages afforded by central-station electric lighting service, the matter can easily be remedied.



Take the fan that kept you cool all summer, and set it where it can blow against a large part of the radiator's surface. Turn it on at low speed, or at high speed if necessary, and your cold room will soon be thoroughly warmed.

The philosophy of the thing is that steam at a low pressure carries much less latent heat than steam at a high pressure, and therefore warms the radiator so poorly that only a slight draft of air rises around the pipes, and condensation is slow.

With the fan in operation there is a forced draft against the radiator that conducts a great deal more heat away from the iron, cooling it so that much more condensation of steam occurs inside it. The heat thus snatched from the reluctant radiator is held in the circulating atmosphere of the room, which is soon changed from cold to warm at a trifling cost for electric energy.

The condensation of the steam makes room for more steam to flow in, and the net result is the same as if the pressure was much higher.

"BOOSTING" THE FURNACE

Where a hot-air pipe from a furnace pursues a devious course to an upper chamber, there is often difficulty in securing enough heat at the register. This can also be remedied with the aid of an electric fan.

The way to do with a floor register is to construct a covering for it out of a box, so that the fan can be set in one side of the box, blowing outward and away from the register. A cardboard cover can be fitted around the fan to make it thoroughly effective, so that its supply of air comes necessarily from the register. A few minutes' use of this device will make a cold room comfortable. Where the register is set in the wall, the box and fan must be supported in front of it in some way.—Copied from *Electric City*, December, 1904. C. H. STEWART.

B 7

A Substitute for a Time Switch on Flat-Rate Signs

In Denver we have many flat-rate signs that burn from dusk till midnight. Where our twelve o'clock arc circuits run in close proximity to the signs, a solenoid switch has been connected in series in the arc circuit, so that the sign is controlled by the arc circuit. This same scheme can be used for operating multiple street lamps. J. F. DOSTAL, Denver, Colo.

B 8

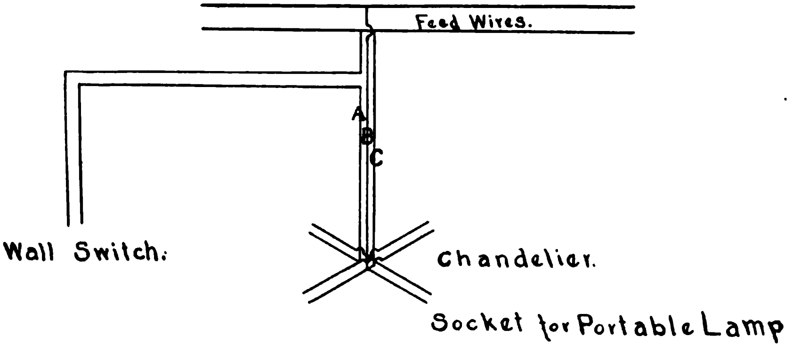
A Handy Chandelier

The following description shows a handy arrangement for an electric chandelier in a library where a portable electric table lamp is used by connecting it to one of the chandelier sockets.

As most chandeliers are operated by a wall switch, all lamps in the chandelier are either turned on or off at the same time, and as a portable table lamp is often used when the rest of the lamps are not, it becomes necessary to turn off, one at a time, the other lamps when the table lamp is used alone.

By running an extra feeder wire to the chandelier, and a third wire through the chandelier to the socket from which the portable lamp is to be connected, the chandelier lamps and the portable lamp may be operated entirely independent of each other.

The following diagram will serve to illustrate the method of wiring:



Chandelier Connections

Care must be taken to get the portable lamp socket connected to wires *B* and *C* and not to *A* and *C*.

E. A. Taylor, Denver, Colo.

B 9

Method of Installing Bell and Push Button on Old System

Several months ago I was called to our leading hotel to install a bell and push button between two rooms. The party was confined to his bed, and wished to call his nurse in the other room.

The hotel was wired on the return call system; we had no bells or batteries in stock, and the job was urgent. After looking over the layout I opened the bell connection on one side, connected lamp cord in series with bell, inserted push button in other end of lamp cord, which I made long enough to reach to patient's bedside. I then had bell and push in series. To get the battery I short-circuited push button at office annunciator, three floors below. It worked all right.

Fred B. Sharpe, Liberty, N. Y.

C

LINES, TRANSFORMERS, SWITCHES, REGULATION, SYNCHRONOUS MOTORS, ETC.

C 1

Method of Protecting Separate Systems of Wiring When Crossing Each Other Without the Use of Guard Wires

In many cases where high-tension lines cross over telephone and other signal wires, it has been necessary heretofore to erect an expensive system of guard wires. It has been found that the expense of this construction can be dispensed with, by the use of a device that automatically disconnects the wire at a point about two feet out from the cross-arm, so that the piece which falls across the signal wires is dead, and can therefore cause no harm.

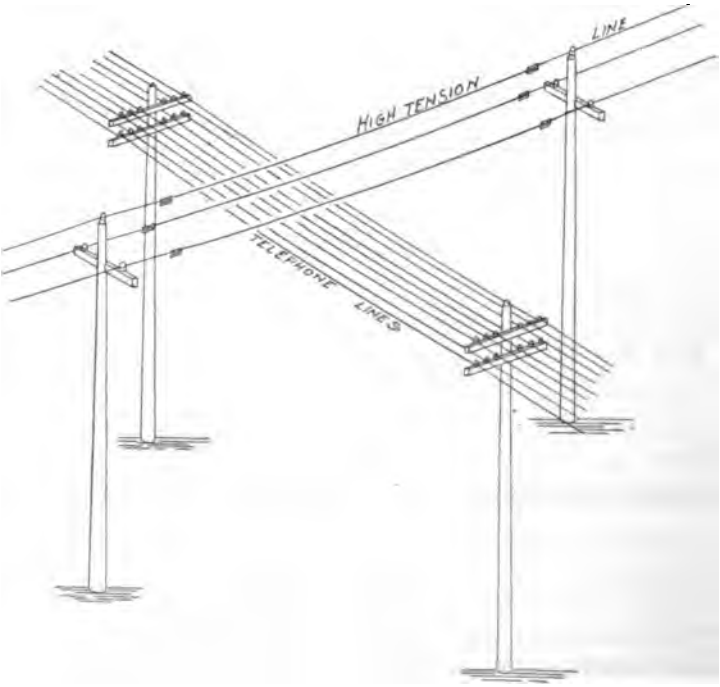


FIG. 1—LINES CARRYING PROTECTING DEVICE

This device consists of a hook, so arranged in the lines that when the tension on the span is released the spring disengages the hook immediately, before the high-tension wire has had time to fall across the telephone line.

This hook is placed inside of a hood, which protects it from sleet or ice that otherwise might prevent its action.

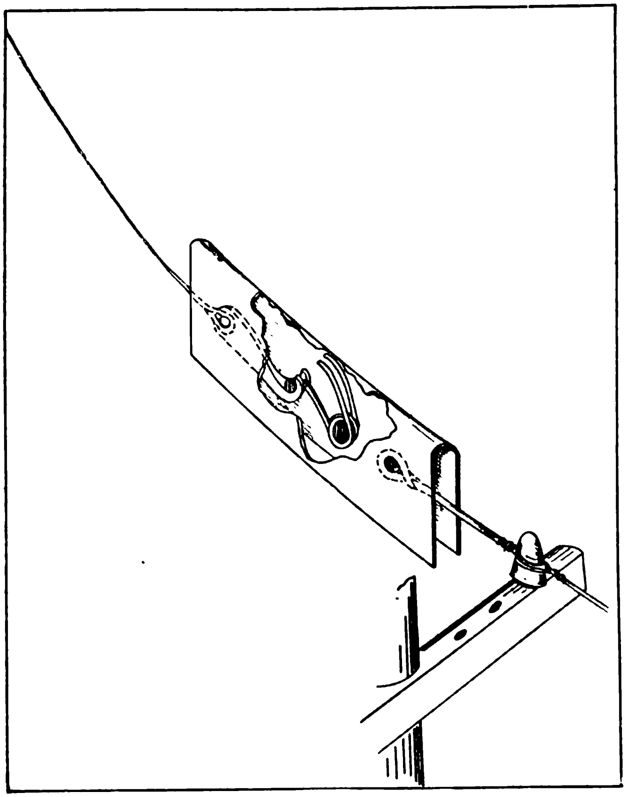


FIG. 2—DETAIL OF PROTECTING DEVICE

The device is also of such a nature that it can be used by telephone companies in places where their wires are above the high-tension wires.

H. B. GEAR, Chicago, Ill.

C 2

Feeder and Branch Switch on Primary

Feeder and branch switches on the primaries out on the pole lines may be so arranged that any district can be cut off without pulling the feeder at the station.

As an illustration: When linemen are working on the lines, transformers or lightning arresters in any particular district, they have positive orders not to work on 2000-volt lines with the current on. This is also the rule when cutting transformers in or out. For locating trouble on high-tension systems these switches are invaluable.

The style of switch that we use is the tube switch, made by the General Electric Company, which was designed for this purpose.

H. J. GILLE, St. Paul, Minn.

C 3

Balancing a Circuit by Grounding the Neutral

We have on our direct-current, 220 to 440-volt, three-wire system, a 75-hp 220-volt motor, which runs from midnight until 6 o'clock a. m. This greatly unbalances the load, and as the motor is a mile and a half from the station the drop in the neutral was at first considerable. By means of switches at each end, the neutral is now grounded while the motor is running, the other wire being of sufficient cross section to carry the current. This has completely overcome the difficulty, and no more trouble has been experienced.

H. S. RUSSELL, Denver, Colo.

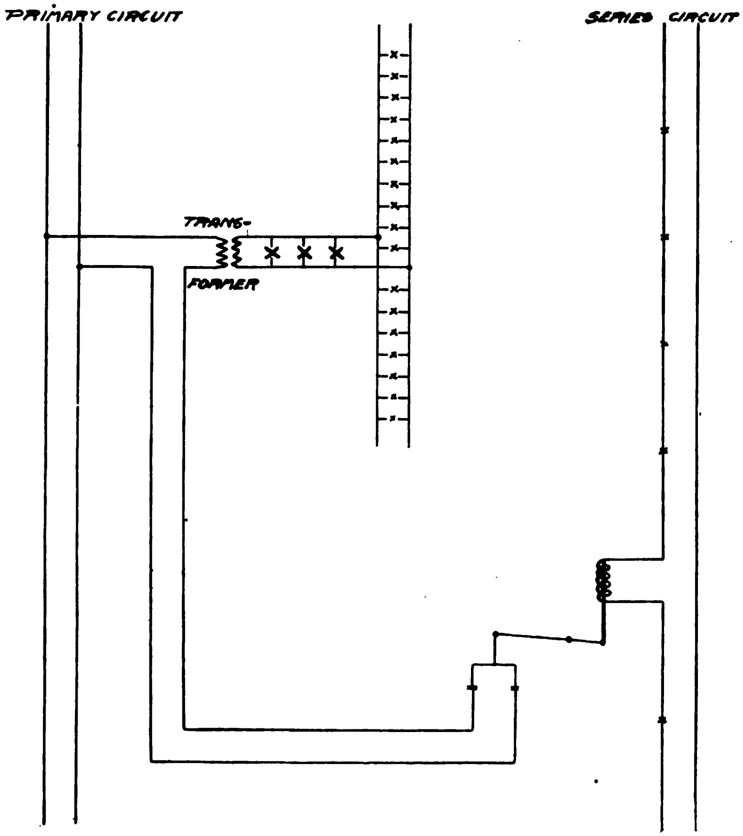
C 4

An Automatic Switch for Controlling Constant-Potential Lights From a Constant-Current or Street-Lighting Circuit

This consists of a pair of arc-lamp magnets with suitable contacts, mounted on a wooden frame and placed in an old 1000-watt transformer case.

The illustration Figure 1 shows switch used to control eighteen 25-cp incandescent street lamps from a 7.5-ampere series arc circuit. The nearest series incandescent circuit was three and a half miles away, and it would not pay to extend the line for eighteen lamps.

They were at first turned on and off by hand, but after being out all night and burning all day a few times this method was found unsatisfactory, and the automatic switch was designed to start and stop the lights when the arc lamps were put on or taken off.



DIAGRAM

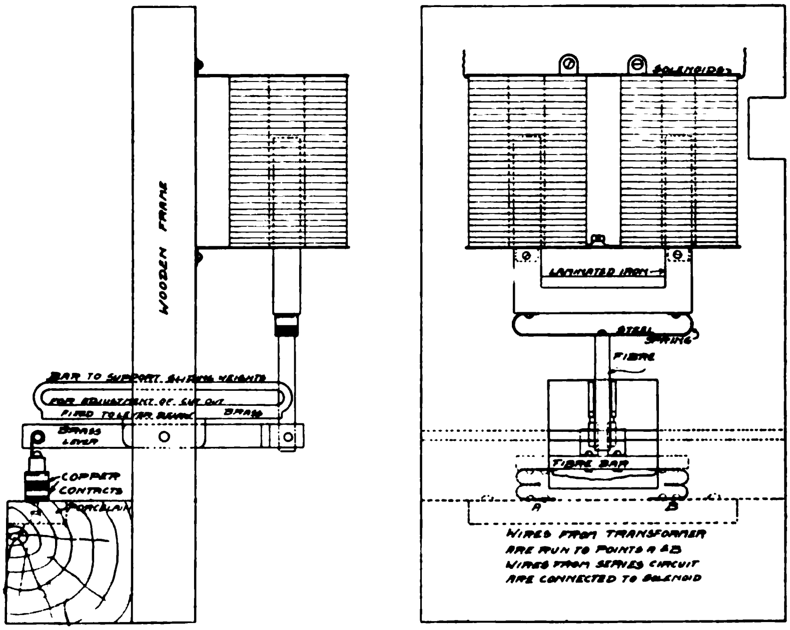
J. T. COWLING, Mt. Vernon, N. Y.

C 5

An Automatic Transformer Cut-Out

The accompanying cut shows outline of switch construction. The same switch is used to control arc lamps from a 1.75-ampere series incandescent street-lighting circuit.

The coils are wound with 220 turns of No. 12 wire, when operated on 6.6-ampere series alternating circuit, with 180 turns of No. 12 wire when operated on 7.5-ampere series circuit, and 625 turns of No. 16 wire when operated on 1.75 ampere series circuit.


WOODEN FRAME
BAR TO SUPPORT SHIFTING WEIGHTS
FOR ADJUSTMENT OF CUT OUT
FIXED TO LEVER BEARING
BRASS
BRASS LEVER
COPPER CONTACTS
PORCELAIN
SOLENOIDS
LAMINATED IRON
STEEL SPRING
FIBRE
FIBRE BAR
A
B
WIRES FROM TRANSFORMER ARE RUN TO POINTS A & B
WIRES FROM SERIES CIRCUIT ARE CONNECTED TO SOLENOID

Switch Construction

This switch will enable a lighting company to pick up incandescent and arc lights where it would not be possible if they were to be controlled by hand or time switches.

J. T. Cowling, Mt. Vernon, N. Y.

C 6

Protecting Apparatus From Water in Case of Fire

The installation of substations in the basements of commercial buildings that are not classed as fireproof buildings makes it imperative that some protection be given the apparatus installed against flooding by water in case of fire.

In a substation recently installed under such conditions a 12-inch pipe was installed in the floor and connected with the service. It is supplied with a valve for normally keeping the pipe closed, but which is to be opened by the operator in case of fire, and as the apparatus is on foundations raised above the floor level, with a water-tight floor overhead, little if any flooding will be possible that this pipe will not care for.

EDISON ELECTRIC ILLUMINATING COMPANY, Boston, Mass.

C 7

Method of Connecting Transformers to Work on Either 1150 or 2300-Volt Primary Lines

We recently changed our system from 1150 to 2300 volts. The old generators were of just sufficient capacity to operate our peak load comfortably. When we completed the installation of our new 400-kw, 2300-volt generators it was necessary to run both 1150-volt and 2300-volt machines, and a portion of our transformers had, of course, to be changed over to this higher voltage; we were therefore obliged to run two large units, one generator of 1150 and one of 2300 volts. To obviate this we arranged two transformers, as per accompanying sketch, which allowed us to

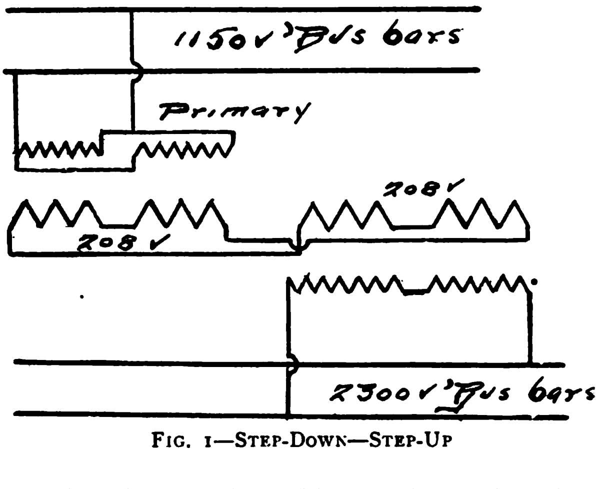


FIG. 1—STEP-DOWN—STEP-UP

operate the 1150 circuits from 2300 'buses or vice versa. This arrangement was all right, but the available transformers were too small even for our minute day load.

We then connected our transformers in the manner described in the diagram under the second method. The primary full-load current of a 10-kw, 1150-volt transformer is 8.7 amperes. The two 1150-volt transformers in series therefore give us 8.7 amperes at 2300 volts, or 20 kilowatts at full load. We sometimes run as high as 35 amperes on these transformers, and the same are doing duty on the line to-day.

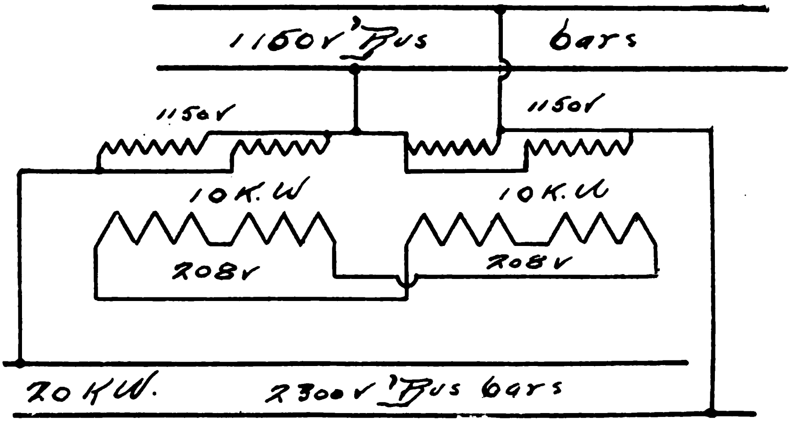


FIG. 2—PRIMARIES IN SERIES

H. J. MEYER, Shreveport, La.

C 8

A Scheme For Operating 1100-Volt Series Incandescent Circuit From a 2200-Volt Circuit

Upon changing the primary voltage from 1100 to 2200 volts, the question came up of what to do with the series incandescent street circuits in one of the suburbs of Denver. To change these circuits to 2200 volts would entail considerable expense and time. It was overcome as follows:

A tap was brought out from the middle point of the primary coil of a 4-kw, 1100-2200-volt, shell-type transformer; the street circuits were connected between this neutral and the outsides, and balanced as nearly as possible. The 2200-volt feed was connected to the two outsides. The voltage was found to be a little low on one side, so the circuits on this side were connected in series with the secondaries of the same transformer, and the voltage thus boosted. The balancing set, as it might be called, has been in operation for two years and has never given a particle of trouble.

J. F. DOSTAL, Denver, Colo.

C 9

Three-Wire Underground Services

In making three-wire underground connections to buildings, either from pole line or underground conduit, run duplex rubber-covered, lead-cased wire, for the outside wires, and bare copper wire, either stranded or solid, depending upon the size, for the neutral; all to be run in wrought-iron pipe, either red-leaded or asphalted inside and out. This makes a cheaper service connection than if the three wires were all insulated, and also helps to ground the neutral better than is apt to be the case where the only secondary grounding done is by digging a hole at the foot of the pole, where the soil may or may not be damp at all times.

P. C. BROWN, Brookline, Mass.

C 10

Transmission Line

During the past year we contracted to furnish a large amount of power to a dredging company situated about eleven miles from our station. This power was transmitted at 11,000 volts, three-phase, 60 cycles, and stepped-down to 370 volts and fed directly to a synchronous converter.

As the dredges were to be moved about considerably, we built a small wooden transformer house of sufficient size to hold three 50-kw transformers and lightning arresters. This house was mounted on a wooden sledge, and by means of a team of horses can be easily moved about. In order to allow the dredge considerable travel without necessitating the moving of the transformers, the secondary leads were brought out of one end of the transformer house in the shape of a single triple-conductor, rubber-insulated flexible cable. This cable lies on the ground, and often lies partially submerged in water. In order to better protect the cable, an ordinary fire hose of extra quality was slung on over the cable. This arrangement has now been in operation for about eight months, and thus far it has given perfect satisfaction.

C. W. HUMPHREY, Denver, Colo.

C 11

Home-Made Oil Switches

A short time ago it became necessary for us to have some oil switches on short notice. We had some old air-brake feeder switches, so we made some tin boxes, filled them with oil and put the old switches in the oil—the switches being placed in a horizontal position with handles at right angles—and led the high-tension wires in through porcelain tubes. This scheme was very satisfactory.

G. F. WILLARD Denver, Colo.

C 12

A Scheme to Bring Up Potential for Alternating-Current Series Arc Circuits

The tub transformer broke down, but we had six old transformers, so we connected the primaries of three of them in parallel across the mains, and the secondary of each was connected to the secondary of one of the other three, and the primaries of the last series were all connected in series to the arc circuit.

G. F. WILLARD, Denver, Colo.

C 13

Splitting Secondary Network Into Sections

About a year and a half ago we had considerable trouble with our secondaries, which are all connected in a multiple network. If a primary fuse blew out it greatly overloaded the other transformers and burned out a number. We very successfully overcame this by making use of a lot of old break arms; we dead-ended the secondary to each side of the break arm and completed the circuit by placing a No. 12 or No. 14 copper wire across the arm.

G. F. WILLARD, Denver, Colo.

C 14

A Simple Remedy for Preventing the Damper Regulator from Working from Extreme Open to Closed Position

This consists of a small plate *X*, about seven inches in diameter, clamped on end of weight beam *K;* two pulleys, *S* and *R*, placed respectively above the plate *X* and the other close to the damper-chain *H*. The small chain *G* to run from top of weight *F* over *R* and *S* to chain *J*, which consists of about 18 inches of chain made of 0.75-inch iron.

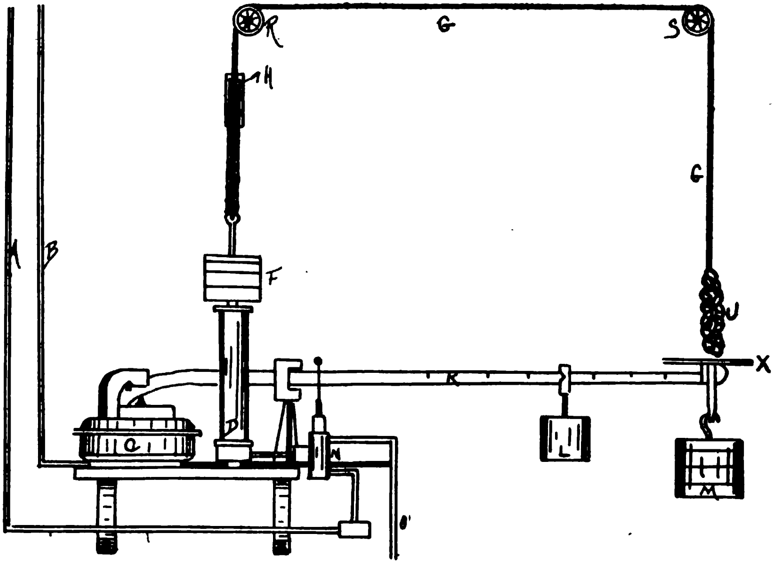


Diagram of Construction

When pressure increases on boilers and raises lever *K*, also weight *F*, chain *G* feeds over the sheaves *R* and *S*, landing chain *J* from plate *X* little by little as the position of weight *F* is changed, thereby increasing the effect of weight *M* as damper closes, which will cause the damper to stop at several intervening points between wide-open and closed positions, with a variation in pressure that will not be noticeable on the steam gauge. As the steam pressure falls on the boilers and weight *F* descends, chain *J* will be lifted from plate *X*, stopping the motion of the damper regulator at several points between the open and closed positions of damper.

This permits the regulator to hold the damper partly closed at all times when the boilers are not pulling at their maximum capacity, and thereby regulates the draft to the exact amount required.

EDISON ELECTRIC ILLUMINATING COMPANY, West Chester, Pa.

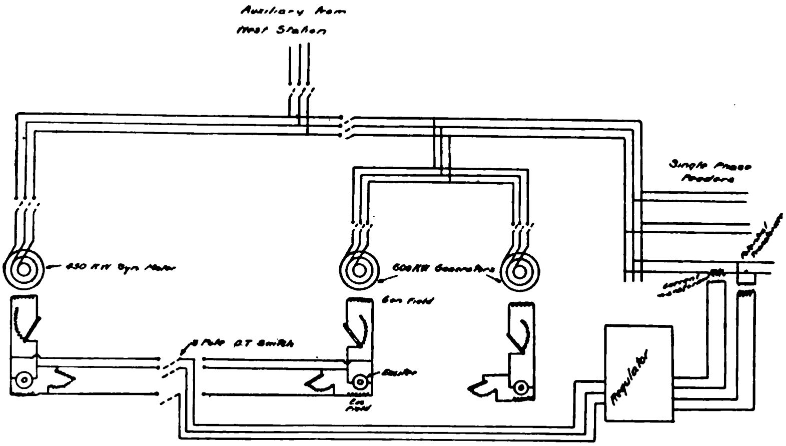
C 15

One Tirrell Regulator Operated Independently on Synchronous Motor and Alternating-Current Generator, Each Machine Having Its Own Exciter

This is done by double-throw switches as per diagram.

The conditions that gave rise to this scheme were as follows:

This company has two electric producing stations about one mile apart, one, however, being many times the larger. They are connected by one 3-phase, 2400-volt auxiliary. Three-wire 440-220-volt direct current is supplied for power by engine-driven direct-current generators at the larger station and synchronous motor-driven generators at the smaller. This power load is, of course, heaviest in daylight, and a portion of it is carried by the synchronous motor all through daylight.



DIAGRAM

Incandescent feeders are carried on the same auxiliary as the synchronous motor, and it is the purpose of the Tirrell regulator to take care of the voltages on these feeders.

The synchronous-motor set is shut down in the afternoon or early evening, and then the regulator is used on the alternating-current generators with no adjustment at all.

C. F. HAYWOOD, Denver, Colo.

C 16

A Three-Phase Booster

A three-phase transmission line is fed from central-station 'bus-bars through raising transformers. It was found desirable to raise the pressure a few per cent above that given by the raising transformers. This is accomplished by means of three single-phase transformers, with primaries wound for the 'bus-bar pressure and a lowering ratio such that the secondary pressure gives the desired boost. This ratio being 10 to 1, a 10 per cent boost is obtained by connecting the primaries star fashion, the secondaries being in series with the respective legs of the circuit. With the primaries connected delta fashion, no change being made in the secondary connections, the boost is about 15 per cent.

The primaries should not be switched in an ordinary manner from one arrangement to the other while the circuit is loaded, since the large current flowing in the secondary, with an open primary, produces dangerously high pressures in the primary coils.

If it is desired to change the percentage of boost with variations in load, this may be accomplished by means of a special switching device which will short-circuit the secondaries immediately upon opening the primaries, and which places the secondaries again in circuit immediately before closing the primaries in the other way.

With transformers of the three-wire type and some auxiliary switches it is possible to obtain four different percentages of boost, as 5, 7.5, 10 and 15 per cent.

J. M. WEED, Denver, Colo.

C 17

Booster Transformer

We have used a transformer for a booster as per drawing attached, and while to many it is not new, yet it is so to some central stations. The transformer must be large enough to carry the main line current in section coils. We wanted a five per cent boost on a line temporarily and found this one way to obtain the results.

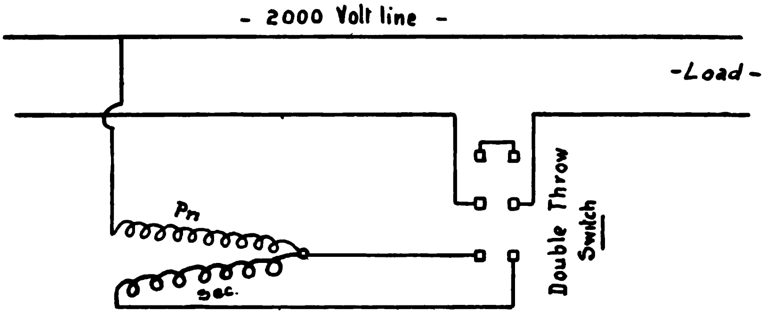


Diagram of Connections

H. E. Ryder.

C 18

Taking Three-Phase Power from Two Single-Phase Lighting Feeders

The accompanying diagram shows a scheme for taking three-phase power from two single-phase lighting feeders when these feeders are tapped, as shown, on all three 'bus-bars by simply running one extra wire to the point where the motor is located.

You will note that the three-phase power is recorded by two single-phase watt-meters, at the same time taking care of the single-phase lighting load, whatever it may be. The potential, current and static transformers are purposely left out of the diagram, to avoid complication, our 'bus-bars being 2300-volt, three-phase. We have C. R. voltage regulators in each single-phase circuit, and can therefore keep the lighting voltage anywhere we want it. We use this scheme on one single-phase lighting feeder that runs two miles to the outskirts of town, along which are

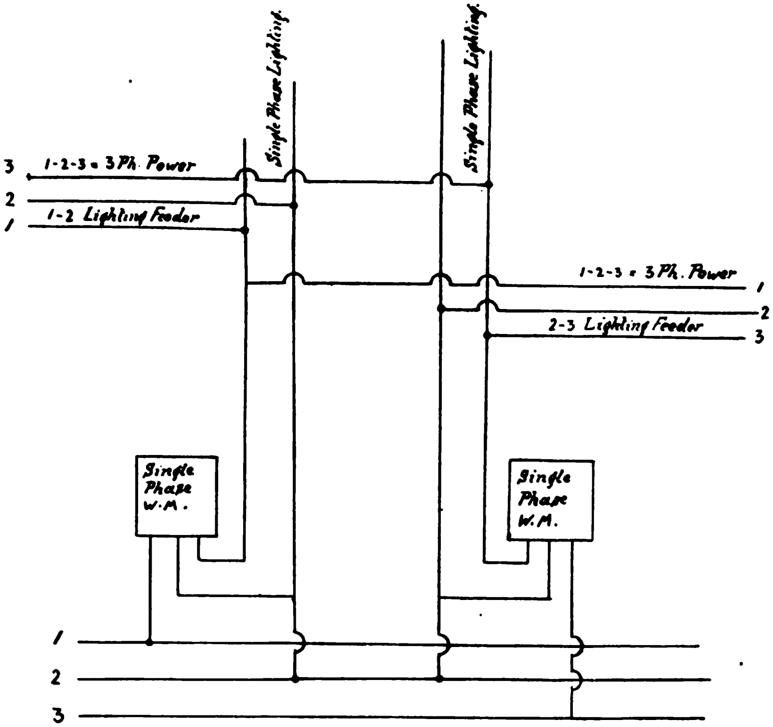


Diagram of Connections

many lighting consumers. We simply run one extra wire, tapping it off the *current*-meter side of the other single-phase feeder.

Austin Burt, Waterloo, Ia.

C 19

Testing for and Locating Breaks in Series Arc Circuits

A customary way of locating a break in a direct-current series arc circuit is to ground one terminal of the arc generator and connect the other to one side of the external circuit. A lineman then "flashes" from various points in the circuit to ground until the break is found. There are three prominent disadvantages to this method: (1) The lineman is subjected to danger of shock from a high-voltage current; (2) if the circuit is discovered open before starting time it is necessary to start up an arc generator simply for testing purposes; (3) this high voltage impressed on the line ahead of the regular starting time is apt to interfere with or result in injury to the company's or other linemen. The same objections, together with others more important, apply to the use of a constant-current transformer in this way.

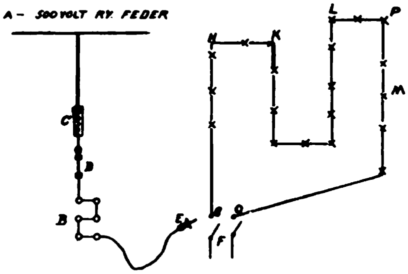
The 500-volt method here illustrated is simple, safe and flexible, and has proved to be very efficient in testing the circuits at all times and in locating breaks and grounds.

A—500-volt railway feeder.

B—Bank of five or six 16-cp, 110-volt lamps connected in series.

C—Fuse.

D—S. P. knife switch.



E—Plug attached to flexible cable connecting with last lamp of *B*.

F—Station switches in arc circuit.

G, H, K, L, M, O—External series arc circuit.

To Test for Open Circuit: Open switches *F*, connect *O* to ground and touch *E* to *G*. Lamps *B* will light up if circuit is closed.

Buffalo & Niagara Falls Electric Light & Power Co.,
Niagara Falls, N. Y.

C 20

To Find a Break in Circuit

Open switches *F*, but do not ground *O*, and connect *E* to *G*. Lower a lamp at, say, *H*, hook one end of an insulated cable to its binding post, and touch other end of cable to fire hydrant, sewer-catch basin or other ground. If there is a spark from cable to ground the circuit must be intact from *H* to *G*. Perform similar operations at successive test points, and retrace steps on first failure to get a spark, as the break will be between this test point and the one preceding.

Buffalo & Niagara Falls Electric Light & Power Co.,
Niagara Falls, N. Y.

C 21

To Locate a Ground on the Circuit

Open switches *F* and connect *E* to *G*. If there is a ground on the line lamps *B* will light up and remain so until line is cleared. Current is flowing in that part of the arc circuit from *G* to the location of the undesirable ground; therefore lower a lamp at test point, remove the line conductor from its binding post and lightly touch it to post. A spark indicates that the point of ground is ahead, and the wire should therefore be replaced and the same operation gone through with at the next test point, and so on until no spark shows the point of ground to be between the last two test points.

This method is somewhat similar to that reported by the Old Colony Street Railway Company in the *Wrinkles* of 1904. but has the advantage of a simpler outfit for the lineman, availability for locating grounds, and absolutely no danger of short-circuiting any apparatus.

Buffalo & Niagara Falls Electric Light & Power Co.
Niagara Falls, N. Y.

C 22

Localization of Faults in Low-Resistance Cables

For the purpose of locating faults on cables of comparatively large carrying capacity, and consequently of low resistance, the Wheatstone bridge, when used for locating faults by Varley and Murray loop methods, is impracticable for several reasons.

An ordinary bridge or testing set especially adapted for locating faults by means of the Varley-Murray loop methods is accurate only when the cables under test are of comparatively high resistance, such as the telegraph or telephone cable. When used for cables of low resistance, as, for instance, a 250,000-cm transmission line, the limitations of such an apparatus are very great, and the accuracy with which the fault can be localized is very low. Also, the calculations involved, while not complex, necessitate a considerable amount of figuring.

While it is a fact that the greater number of faults in underground cables occur in the manholes of the transmission lines, it is nevertheless desirable to locate the fault with the greatest possible accuracy. The readiness and ease with which such a test can be made is quite important when considered from the standpoint of economy in line maintenance.

The location of the ground or cross on a cable can be very easily accomplished by the following method, which utilizes a slide wire bridge for testing by means of the Murray loop.

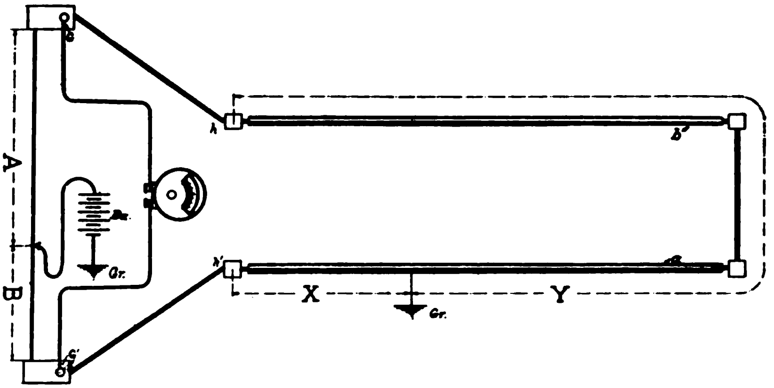


Diagram of Connections

A slide wire bridge having a bridge or slide wire of very low resistance (say .5 ohm) and which has a scale divided into a given number of parts is connected as follows:

A cable on which the ground is located is connected to one end of the slide wire and a perfect cable of known length is connected to the other end. The distant ends of the cable are connected together by a jumper or clamp of negligible resistance. A milli-voltmeter having its zero in the middle of the scale or a very low-resistance galvanometer is connected across the slide wire as shown at *G* and *G'*. The contact-maker on the slide wire is connected to the one terminal of the storage or primary battery (preferably one of very low resistance); the other terminal of the battery is grounded. The e.m.f. of the battery need not be over a few volts, except for very high-resistance grounds. Using the ordinary Murray loop formula as follows:

Let L = total resistance of cables A and B.
X and Y = resistance to faults.
A and B = value of bridge arms when balance is obtained.

Then

$$X = \frac{B}{A+B} L$$

In applying this formula to the slide wire bridge $A + B$ is obviously constant, and we will consider it as having unit value. We will also consider that L has unit value; therefore L and $A + B$ are eliminated by cancellation and

$$X = B.$$

B is then a decimal which, when multiplied by the length in feet of the cable, will give the value of X in feet distance of the ground from G'.

In practice the cable must be connected to the bridge by leads of as low resistance as possible. If the maximum accuracy is demanded, then the resistance of the leads must be considered. By connecting the milli-voltmeter to G and G' the error due to the leads T and T' is included in the length of the cables under test and a suitable correction must be made. If the galvanometer is connected at the junction of the leads h, h' to the cables A and B, then the leads form an extension of the slide wire. In this latter case, the leads being equivalent to a definite number of scale divisions on the slide wire, the scale of the bridge will not then begin at zero, but will start at the figure which corresponds to the number of scale divisions to which the leads are equal. In simplifying this method still further the following plan is suggested:

Given a bridge divided into 1000 parts, each division up to the center of the scale will correspond to a definite point on A cable, and each division after passing the center of the scale will be a definite point on B cable.

If then a number of thin strips of sheet metal are cut to the exact length of the slide wire, a cable can be scaled to the length of the slide wire and the positions of the manholes, sections, etc., scribed on the metal strip.

One of these strips may be made for each cable or set of cables and may be made in a short time and at a slight expense, and when once made serves for all time. In making a test the strip corresponding to the cable under measurement may be laid on the scale of the bridge and the location of the fault may be read directly from the scale.

Under favorable conditions an accuracy of one-twenty-fifth per cent is obtainable, and under ordinary conditions an accuracy of one-tenth per cent is practical.

This bridge may be constructed at small cost, obviously dependent on the degree of accuracy with which measurements are required.

H. E. RICE.

C 23

Exciter for Synchronous Motor

This company recently installed a 400-kw synchronous motor at one of its stations, to be used both as a feeder regulator and to drive two direct-current machines belted to it. Its operation was very unsatisfactory, as the incandescent feeders, operated from the same 'bus-bars, gave a very noticeable flickering of the lamps, the voltage varying constantly two volts either way from an average.

We thought the trouble due to the fact that the exciter was run from the synchronous-motor shaft, and accordingly belted it to a separate motor run from a separate feed. This has obviated all fluctuations and the entire set is now giving satisfaction.

C. F. HAYWOOD, Denver, Colo.

C 24

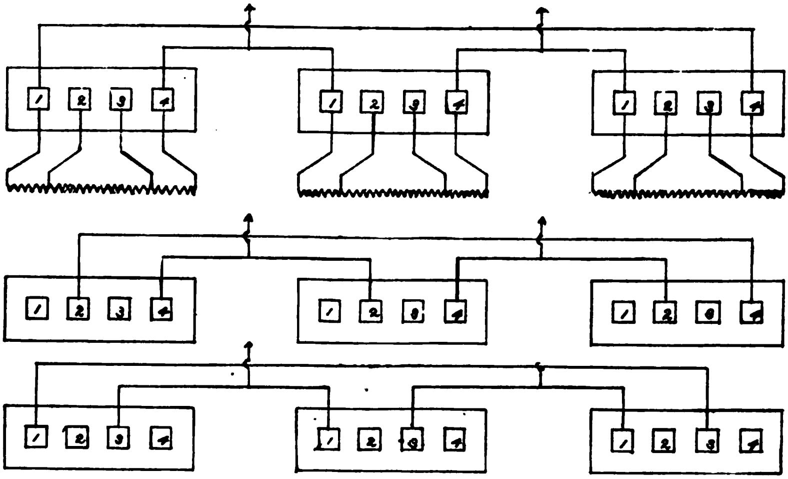
An Interesting Rotary Converter Installation

We have an interesting rotary converter installation which was installed by the Westinghouse Electric and Manufacturing Company. This converter is 300-kw and has operated under the following conditions in a very satisfactory manner:

Taking current at the direct-current end and supplying our three-phase motor system with current, alternating.

Taking current from the alternating-current end and operating the 250-500-volt, three-wire power system, direct current.

Taking current from the alternating-current end operating our railroad and 50 per cent overload and three-wire, 250-500-volt system at the same time.



FIGS. 1, 2 AND 3

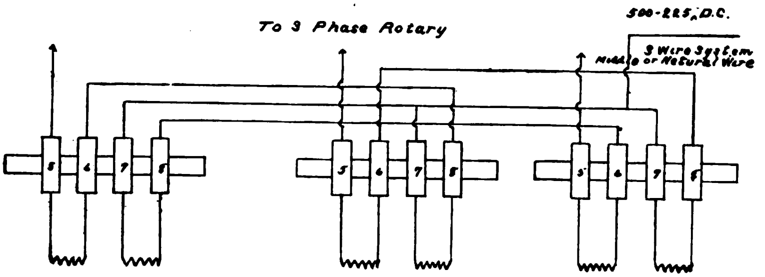


FIG. 4—DIAGRAM OF CONNECTIONS

Taking in direct current at 500 volts, split it up into a three-wire, 250-500-volt system.

Run it as a synchronous motor, also a direct-current motor-driving arc machine.

Belted to an engine, we got 2000-volt alternating and 250-500-volt direct current.

Taking in alternating and operated direct-current end in parallel with a 750-kw steam-driven generator.

Taking in direct current and operated alternating-current end in parallel with a steam-driven alternator.

Diagram shows connections.

Figures 1, 2 and 3 are views facing high-tension terminal boards of three-phase step-up transformer; Figure 4, view facing low-tension terminal bars.

2200-volt, three-phase No. 1 }
2100-volt, " " No. 2 } give 315 volts three-phase.
2000-volt, " " No. 3 }

In Figure 4, facing the high-tension terminals the coils are numbered consecutively from left to right.

O. N. Bundy, Elmira, N. Y.

C 25

Direct-Current Power Machines at Substation Driven by Synchronous Motor

These power machines feed into the same lines as the engine-driven power machines at the main station. The motor-driven power machines are used as motors, taking current from the main station to bring the synchronous motor to speed at starting.

The motor current in the series field winding of the machines overpowers the shunt winding, so that the machines refuse to start, and produce practically a short-circuit upon the lines, opening circuit-breakers, etc. Switches were placed upon the machines for reversing the connections of the series winding at starting. After the motor is synchronized and the power machines loaded the series coils are cut out by means of a single-pole switch, while the reversing switch is thrown over to give the proper compounding effect.

It is often desired to run this apparatus through short periods of small loads rather than shut down and start over. When the load drops as low as one-quarter full-load equilibrium becomes unstable, due to the absence of an equalizer, the load all being taken by the main station. Worse than this, the power machines begin taking current from the lines and supply energy to the alternating-current lines through the synchronous machine. The increasing motor current in the series winding of the power machines overpowers the shunt winding, causing the torque to pass through zero and reverse, coming up so high as to pull the alternator out of synchronism. The remedy for all this is, of course, to throw the reversing switch to the starting position when the load is small, making proper voltage adjustment by the shunt field. The equilibrium is then stable.

J. M. WEED, Denver, Colo.

C 26

Synchronous Motors As Alternating-Current Generators

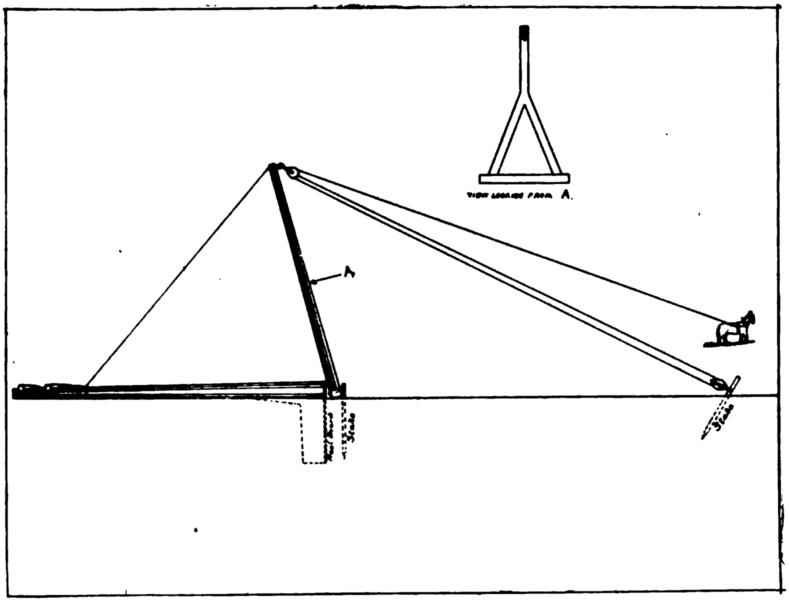
At Montgomery, Ala., four direct-current, 500-volt generators are operated by synchronous motors, which are driven by the current from a water-power plant thirty miles away. The motors and direct-current generators are so arranged that they can be operated by steam engines in case of any trouble, or any shutdown at the hydraulic station. The synchronous motors are then driven by the engines, and become alternating-current generators, furnishing the alternating current.

W. WHEELER, Montgomery, Ala.

C 27

A Quick Method of Planting Poles

In constructing the transmission line from Montgomery to Tallassee, Ala., it was necessary to erect over 1500 poles, varying from 35 to 65 feet in length. Many of them had to be erected in wet and swampy ground, where pikers could not be used. The poles were fitted up with cross-arms, pins and insulators, and erected by a horse pulling on a breast derrick, as shown in sketch. At the point where the rope from the breast derrick is attached to the pole to be raised, four or more guy ropes were attached, so that the pole could be lined up by a man pulling on the guy rope in any direction the pole had to go. The guys were fastened to the pole in such a way that by pulling on a small half-inch rope after the pole was in position all the ropes were dropped to



Raising Pole

the ground without the need of a climber to unfasten them. This arrangement proved to be a great saver of time and labor.

G. A. Montgomery, Montgomery, Ala.

C 28

Setting Line Poles in Concrete

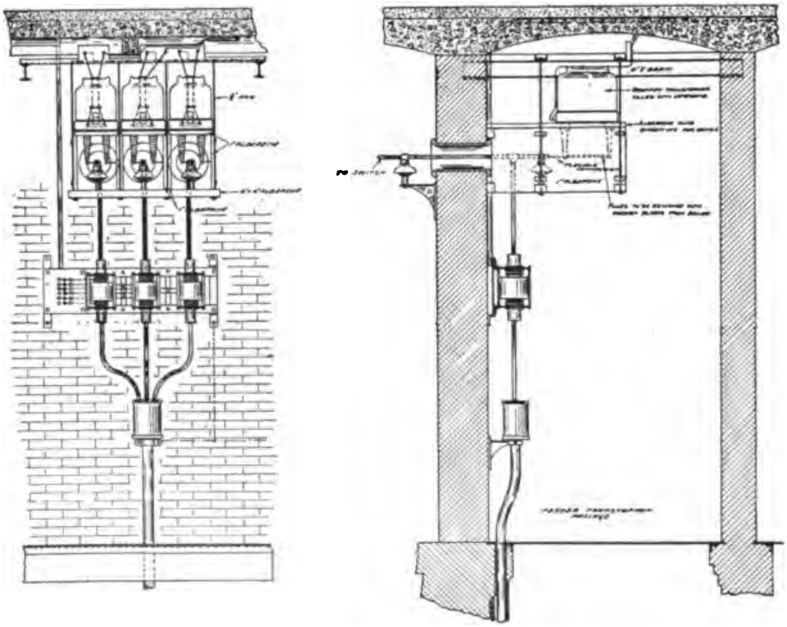
Where line poles are to be set in concrete, use cinders about one inch in diameter in place of stone in making the concrete. This is cheaper than cracked stone, where station is run by steam power, is sufficiently strong to make a good setting, and is much more easily broken out than concrete made with stone when the pole has to be reset or removed.

P. C. Brown, Brookline, Mass.

C 29

Potential Transformer Inverted

The accompanying diagram shows an ordinary potential transformer inverted. The iron cover was removed and the transformer filled entirely with compound. This compound will not flow at the temperature attained in practice. An alberene slab was substituted for the cover to eliminate all iron or ground near the fuse. Placing the transformer in an inverted position enables the operator to remove the fuses with a pair of wooden pliers when standing below same. It also eliminates the danger of the fuse wire of a broken holder dropping to the case of the transformer which may start an arc and be dangerous to life and apparatus. This construction also eliminates the danger of rats and cats coming into contact with live terminal and thus start an arc to ground. EDW. SCHILDHAUER.



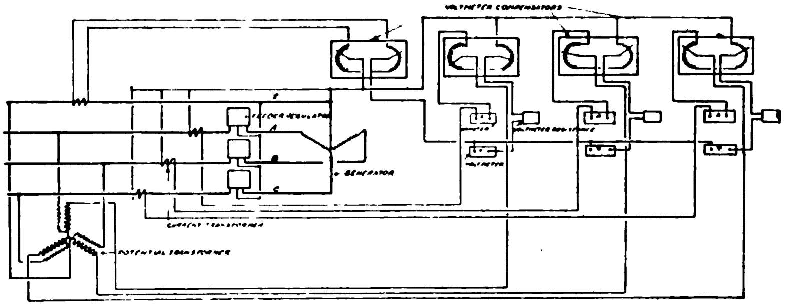
POTENTIAL TRANSFORMER INVERTED

C 30

Voltmeter Compensators on Four-wire, Three-phase Circuits

In order to secure maximum efficiency of feeder copper in connection with single-phase lighting circuits on three-phase, four-wire distribution systems, three single-phase feeders running along the same pole line for a portion of their length should be combined along such portion into four-wire, three-phase feeder. The loads on the three feeders will, in general, be unequal, and the common neutral wire will carry the unbalanced current. Under these conditions, and where voltmeter compensators are used in the station, some difficulty has been experienced in securing on the feeder voltmeter a correct indication of the voltage at the feeder ends. The diagram herewith shows a scheme of connection for voltmeter compensators which accomplished this result.

It will be noted that a voltmeter compensator is installed on the neutral wire as well as on each phase wire. The neutral compensator is adjusted to compensate for the drop in that portion of the neutral wire that is common to all three circuits. Each of the compensators on the phase wires is adjusted to compensate for the drop from the end of the common neutral to the feeder end and back to the station. In other words, the compensator on each phase wire is adjusted to compensate for the drop in that portion of the circuit traversed by the current shown by the ammeter on that phase, and the neutral compensator is adjusted to compensate for the drop due to the unbalanced current in the neutral wire. In general, current in the neutral wire will not be in phase with the current in any of the phase wires, but if the connections of the compensators are made as shown



WIRING DIAGRAM OF VOLTMETER
COMPENSATORS FOR 4 WIRE 3 PHASE FEEDER

Wiring Diagram

and the compensators properly set, the voltmeters at the station will indicate the voltage at the end of the single-phase feeders regardless of the distribution of load on the three circuits. It is always advisable to check the compensator settings by observations of the voltage at the feeder end.

D. W. Roper, Chicago, Ill.

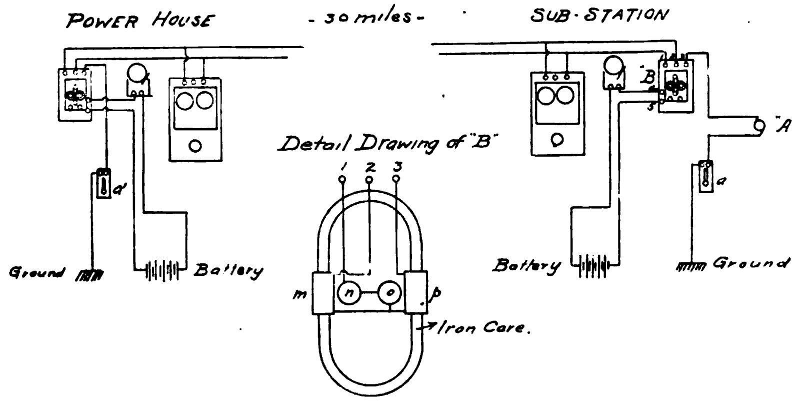
D

TELEPHONES

D 1

Signal Device for Long-Distance Transmissions

In long-distance transmission work it is essential that the power-house and substation should always be in communication, the one with the other. Experience has taught us that the telephone is not always reliable, so a signal device has been arranged in order that in the event of one of the telephone lines being down the operators in the power-house and substation can exchange messages by using a code of signals. The enclosed sketch of connections will probably make this clear to your readers.



Diagram

At the substation end there is a small single-phase induction motor direct-connected to a direct-current generator, 0.25-kw capacity, wound for 110 volts, as shown by *A* in diagram. The terminals of this generator are connected to ground and to binding-post 1 of telegraph relay *B*. As shown in detail drawing of *B*, this binding-post is connected through the relay coils *n* and *o* in series, to the two coils *m* and *p*, which are connected to the line terminals 2 and 3. Binding-posts 4 and 5 are connected to the local gong circuit. We have the same arrangement at the hydraulic station, except that the binding-post 1 of relay is connected straight to ground through contact *a'*, forming return circuit to generator *A*.

When contacts *a* and *a'* are closed, causing current to pass through the coils of relays, the magnets are attracted, and hold lever-arm of relay down. If the operator in the substation or power-house wants to signal he opens the ground circuit at *a* or *a'*. The magnets then release the relay arm, which in turn short-circuits binding-posts 4 and 5, thus closing the local gong circuit. As long as either of these contacts *a* or *a'* are open the bell will continue to ring. By combinations of short and long rings, corresponding to dots and dashes, we have arranged a code of signals that answers the purpose very well when we have trouble with the telephone. G. A. MONTGOMERY, Montgomery, Ala.

D 2

Telephone Signal

It is not always possible, when there is much noise in a station, to hear the telephone bell, so a central-station drop has been arranged in shunt with the telephone box. When the drop is down a circuit with a red lamp is completed. By making the proper arrangement when the drop is down, the drop-ringer is thrown out of circuit and the telephone is thrown in.

H. C. GRAY.

D 3

Inductive Effect on Telephone Line in Long-Distance Transmission Work

We have experienced considerable trouble on our private telephone line between the substation and the power-house.

Originally the line was run on brackets spaced about six feet below the transmission line, with running transposition between every two poles. The wire on top at one transposition would be under at the next. At times it was very difficult to hear any conversation over the line. This trouble was remedied to a large extent by running the line on two-pin cross-arms and transposing at every fourth pole. The transposition was made on an insulator for that purpose, first on one side of the line, and then on the other. The wire that was above the other at the first transposition is always kept on top. That is, every time the line is transposed we find the same wire on the upper groove of the insulator. This method of transposition was found to be a big improvement over the old method, as we can now hear very distinctly over the new line. A. L. LOWRIE, Montgomery, Ala.

D 4

Method of Using One Telephone on Two Floors

Several years ago our company was paying for two telephones, one up-stairs and one down-stairs. During the daytime the down-stairs telephone was seldom used. I made a box extending from the first floor to the second floor, and in this box I placed the up-stairs telephone, arranging it so it could be raised or lowered something like a dumb-waiter. The telephone wires were connected to two brass rods, which extended from the first to the second floor in the box, and connection was made from these rods to the telephone through sliding contacts which were open-arc lamp carbon brushes. A counter-weight was attached. During the daytime the telephone would be at the top, and used in the office on the second floor. At night the telephone would be pulled down-stairs and used there. This has been used for a number of years, and saves the company $75 per year.

F. ELLWOOD SMITH, Somerville, Mass.

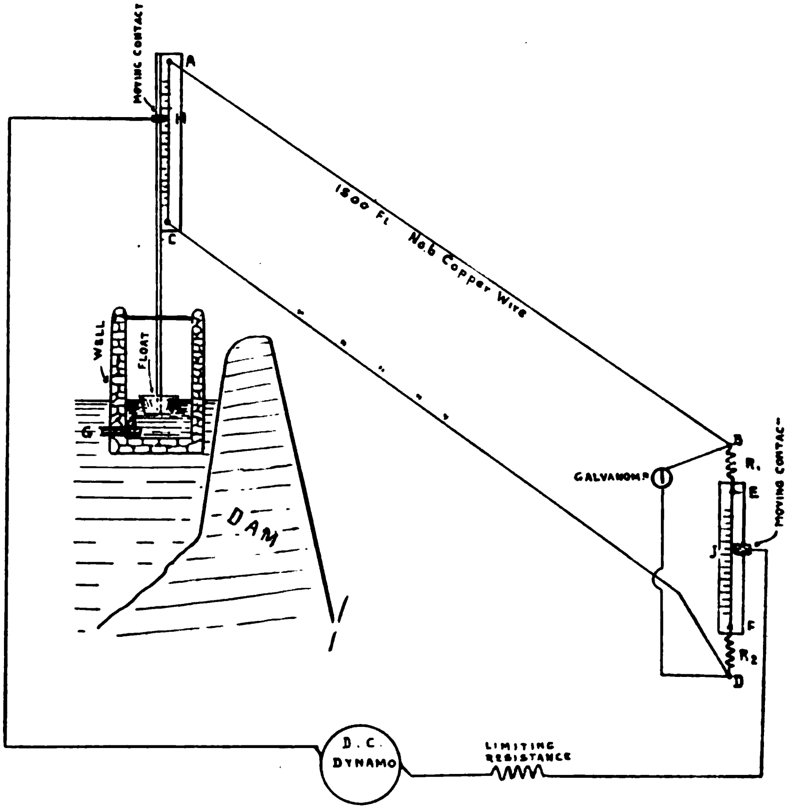
E

WATER-POWER PLANTS

E 1

Device to Measure in the Power-House the Height of Water at a Dam When the Power-House and Dam Are Some Distance Apart

Device to measure, in the power-house, the height of water at a dam when the power-house and dam are some distance apart.



A shanty is built over the well and kept warm by an electric heater.

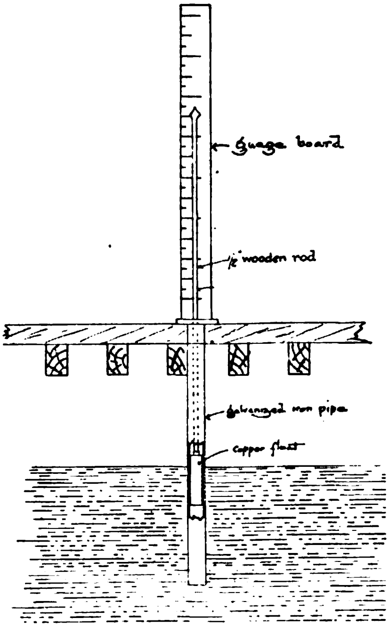
AC and *EF* are No. 18 German silver wires mounted on maple plank about 6 feet long and divided to one-tenth of a foot. *H* is a moving contact, moved by the float in the well, which communicates by the pipe *G* with the water in the dam. The pipe has a valve at the inner end. The contact *J* is moved by hand until the galvanometer reads zero. The resistances R_1 and R_2 are equal to the resistances of the wires *AB* and *CD*. The current used is about 3 amperes. When a balance has been obtained, the height of water is read directly from lower scale

Fred R. Cutcheon, St. Paul, Minn.

E 2

Head and Tail Race Water-Level Indicator

The sketch shows a style of float we have in use to indicate the height of the water in our penstock; another float of identical construction shows the height of the tail water, and, of course, the difference between the two floats is the available head on our turbines.



Water-Level Indicator

The arrangement is very simple and inexpensive, and if the float is made large enough as to contain sufficient air, it is quite sensitive.

S. R. Inch, Missoula, Mont.

E 3

An Indicating Head-Water Gauge for Open Flumes

It is at all times desirable to know the exact head under which a water-wheel is operating. A handy gauge for this purpose can be made as follows:

A float, consisting of light wood or other material, is placed in the open flume, and a light rod or stick is fastened to it by nailing or screwing. The stick or rod must be of sufficient length to permit of a satisfactory guide being placed above high-water level to prevent the float from drifting down-stream. The guide may be made of a block of wood nailed to the flume and bored for the vertical rod, or a large screw-eye may be attached to the flume. At the end of the vertical stick or rod attach a wire, and run it over small pulleys to any convenient location for the scale. This should be a stranded wire, and ordinary picture cord will usually be found suitable. At the place selected for the scale the wire should be run over a small pulley, and should drop vertically, the end of the wire being attached to a weight heavy enough to keep the wire taut at all times and counter-balance the weight of the rod and float to some extent. Attach to the wire a few feet above the weight, by means of a small clamp, or by double-pointed tacks, a scale divided into feet and inches. This scale should be of such a length that the extreme variation of head will come within its limit.

For the tail water an exactly similar float rod, guides, wire, pulleys, etc., should be used, and the wire dropped vertically, with a weight on the end and as near the scale as possible.

A pointer should be attached to the tail-water wire in such a position that it points to the center of the scale when the head is normal. Measure the head accurately with a tape line, or by other means, and mark on the scale at the place indicated by the pointer; extend the scale as much as desired, and you will have a convenient gauge. Other scales may be placed near the wires at convenient points and adjusted so that you may know the inches or cubic feet of water flowing over the dam, or the loss of head due to rise of water in the tail race.

Loss of head in racks, gates or flumes can also be indicated in a similar manner.

FRED B. HUBBELL, Westport, Conn.

E 4

Increasing Storage Reservoir by Means of Flash Boards

In order to obtain a greater water storage here, and to increase the working head on turbines, flash boards have been placed on our two dams, raising the level in forebay 2.2 feet.

The construction and effect is as shown in photographs, permitting them to be readily placed on dams, and removed when desired. They are put on and filled before the winter low-water season begins, and removed before spring freshets.

The frames are built of two-inch tamarac, and the cross-planks of three-inch pine; they were placed on two dams—a total length of 300 feet—for $340.

G. Hartman, St. Gabriel, P. Q.

E 5

Maintaining Cooling Water in Transformers

We have a set of transformers, cooled by coils of iron pipe, through which water circulates. The coils are fed from the main turbine feed-pipes, and at certain seasons of the year the level of head-race is liable to drop several feet below the highest points of cooling coils.

To avoid the collection of air at these points, and consequent interruption of flow, the discharge from the cooling coils is connected to one of our exciter draft-tubes, thus securing uninterrupted flow during all conditions, with no perceptible effect on steadiness of exciter vacuum or speed.

G. HARTMAN, St. Gabriel, P. Q.

E 6

Removing Accumulations of Sand, Debris and Anchor Ice from Flumes and Racks by Means of a Stream of Water from a Fire Hose

We use city water-pressure of 70 pounds per square inch, but I think anything over 30 pounds would be effective. The method of application will vary in each individual case.

In our flume we have found that anchor ice will not go out of the sluiceways, but will gather in masses in front of our racks and on the surface of the water to a depth of a foot or more, and if allowed to remain would soon cause serious trouble. By the use of the hose, held at an angle with the surface of the water, we can drive the ice out of the sluiceways in a few minutes, while it would take an hour to do the same work by other means. It will be found equally effective in washing out wheel-pits, forebays and flumes when the water has been shut out for repairs, etc. We also make use of this means to deepen the channel of the river leading to our intake when the water is low in summer.

J. C. FAGAN.

F

STEAM ENGINES, GAS ENGINES, PRODUCERS, PUMPS, BOILERS, FEED-WATER, HEATERS, ETC.

F 1

Removing Crank Pins

Some time ago we were obliged to take out and replace a crank pin on a 250-hp engine. The pin was shrunk in and pened over, as is the custom, but had become a little loose; still we could not force it out.

We drilled a hole through the centre of the pin from end to end, tapped each end to fit a three-quarter-inch pipe thread, and screwed a piece of pipe in the same with a cold-water hose attached to one end of the pipe. After heating the crank and pin to a cherry red by the use of a portable forge we turned on the water, cooling the pin, which shrunk enough so it could be pulled out by the attached pipe.

C. E. INMAN, Warren, Ohio.

F 2

Silent Chain-Drive to Replace Governor Belt

Since it is the duty of a governor on an engine to adjust the supply of steam admitted to the cylinder to suit the load, the medium of transmission of power to drive the governor must act as quickly as possible. We know that it is the duty of the flywheel to take care of the variations of load instantaneously, while the governor adjusts same by controlling the steam—taking a comparatively longer period of time to do so. We also know that under best conditions possible there is belt slippage, and furthermore that a belt may break without giving any warning.

To overcome these deficiencies we have replaced the governor belt on three engines by a silent chain-drive, and we are well pleased with the change. To do this a special sprocket wheel has to be made to fit over the engine shaft; a sprocket is also made to replace the governor pulley.

The silent chain-drive has four advantages over the belt, in that it can not slip, it does not stretch, oil does not ruin it, and it is stronger.

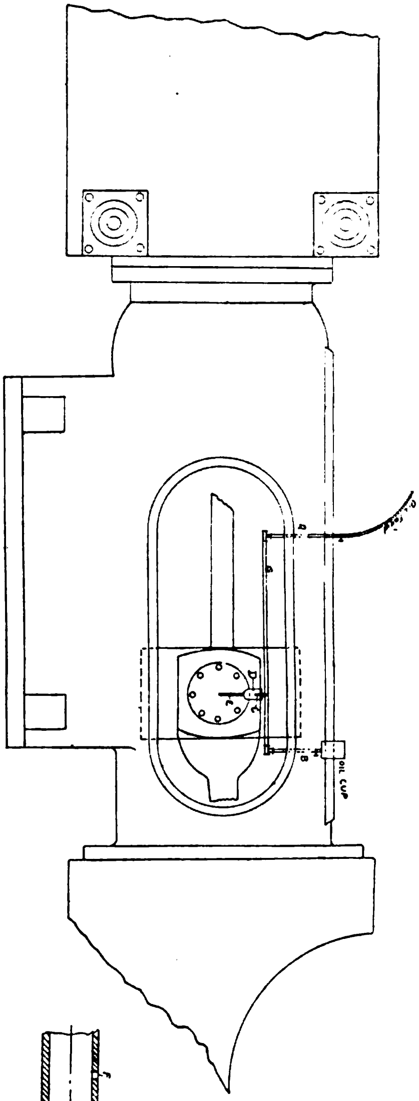
G. H. CUSHMAN, San Antonio, Tex.

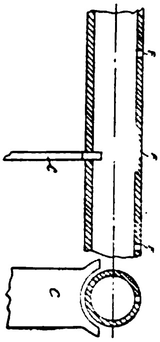
F 3

Device to Lubricate Freely the Crosshead of a 1500-Hp Corliss Engine

After experiencing a little trouble with the crossheads on the high and low-pressure sides of a 1500-hp Corliss engine, due to the fact that the crossheads did not receive enough oil, we resorted to a scheme illustrated by the accompanying sketch.

The crosshead formerly received its lubrication at one point only, in its travel back and forth, this point being *A*. The wiper *C*, as it passed under *A*, collected the oil, allowing it to pass in the cup *D*, down the stem *E*, and then to the crosshead. However,





Sectional view of Pipe B.

if the engine was running heavily loaded, and the wiper *C* should fail to collect oil for a stroke or two, the brasses would clamp the pin tightly and would result in shearing the bolts in crosshead, thereby causing a serious shut-down.

To eliminate grief from this source, the crosshead is oiled for the full length of its stroke instead of at one point only. To accomplish this, a half-inch brass pipe *G*, its length depending on length of stroke of engine, is fixed to the guide barrel, the barrel having been tapped again at *B*, with oil cup attached, to be used in case of accident to the automatic feed. The pipe is placed just high enough to miss hitting the wiper *C*. In the sectional diagram of the pipe, note that the holes from which the oil escapes are bored in the top of pipe and are one-sixteenth-inch in diameter, spaced about every two inches. The holes are bored in the top in order to make the lubrication uniform throughout the stroke. When the pipe fills, oil flows from the holes *F* at the same time, and is collected by the wiper *C* at every point of the stroke. Seemingly, there is quite a bit of oil wasted, but the oil is caught and used again.

G. H. CUSHMAN, San Antonio, Texas.

F 4

A Device for Continuous Feeding of Oil to Engine Cylinders

This device consists of tank *A*, which must be connected to a high point in main steam pipe through pipe *C*, and the pipe *E* leads from top of tank to the engine lubricators *K*, *K*, as in the ordinary cylinder-tank system.

To start system remove plug *J* in tank *A*, having valves *K* and *L* closed. Reset plug *J* perfectly tight after filling tank *A*, open valves *K* and *L* when system is ready to start.

To refill tank *A* place tank *B* below tank *A*, extend pipe *C* to bottom of tank *B*, then connect top of tank *B* with one-inch pipe to top of tank *A* with cut-off valve at top of tank *B*, provide filling plug at *G*, pet cock at *H*, and drain cock at *I*.

To fill tank *B* have valves *M* and *N* closed, also drain cock *I*, remove plug *G*, open pet cock *H*, fill tank full of oil, close plug *G*, slack valve *M* until all air is excluded at *H*. Close *H*, open *N* and *M*, and oil will pass from *B* to *A*, water in *A* returning through extension in pipe *C* to *B*.

In this manner tank *A* can be filled continuously without interrupting the supply of oil to the cylinders.

A pet cock should be inserted in pipe *E* at the highest point in the system, for an air vent, but will seldom be needed, except for starting.

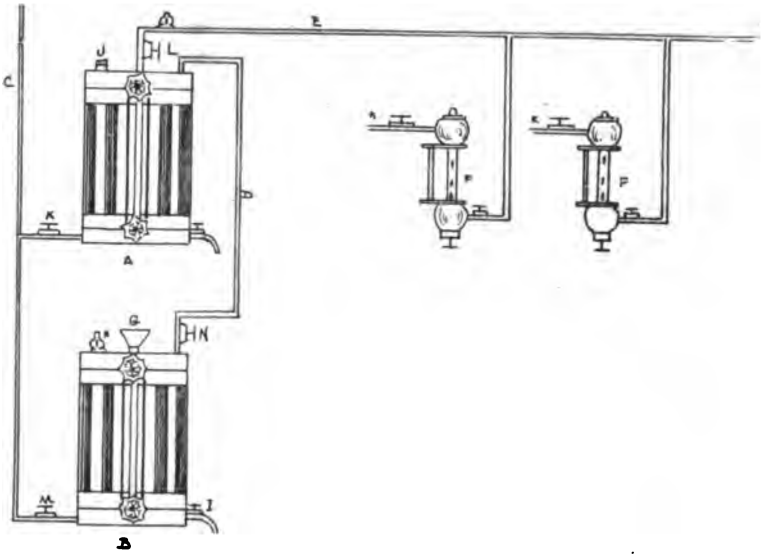


DIAGRAM OF CONNECTIONS

EDISON ELEC. ILLUMINATING CO., West Chester, Pa.

F 5

Curing an Engine That Took Water Frequently

An engine taking steam from the extreme end of a long line of piping was troubled frequently with water; taking the cap off the end of the steam line, and putting on a drop elbow, with a drip from the bottom of it leading to the drip system, cured it.

H. C. HALL, Fall River, Mass.

F 6

Detecting Leak in Receiver

A receiver drip on a vertical tandem compound-condensing engine was found hot after the engine had been shut down several hours; throttle valve was found to be tight, so the only place left to look was the reheating coil in the receiver; to take head off the receiver was a long, awkward and tedious job, so to find whether the leak was large or small all drips were closed, also valve between engine and condenser, and by noting pressure on receiver gauge the desired information was soon obtained.

H. C. HALL, Fall River, Mass.

F 7

Method of Testing a Large Gas Engine Without a Brake

It was necessary to test a large producer-gas engine, driving a 700-kw, 13,200-volt generator. The only available electric load was too variable to be of any use, so the following arrangement was adopted:

A triangular float, supported by oil barrels at the corners, was constructed with out-riggers supporting high-tension insulators. The three-phase line was led to an upright in the middle of the float, and thence one leg to each out-rigger. A short bar of No. 00 bare copper was used as a terminal dipping into the river.

With about one-half inch of the terminals submerged at 20 feet distance, full voltage, full load was obtained.

A comparatively slight variation of generator voltage would vary the load from one-quarter to full, and the same could be held absolutely steady at any point. A perfect load and regulation test was obtained on the engine.

It was observed that nearly all the resistance was at the contacts, the distance apart of the electrodes having no effect from six to 20 feet.

At heavy load the electrodes made no contact with the water, but were surrounded by a ball of incandescent gas, approximately two and a half in diameter, which formed the conducting medium.

M. A. MAXWELL.

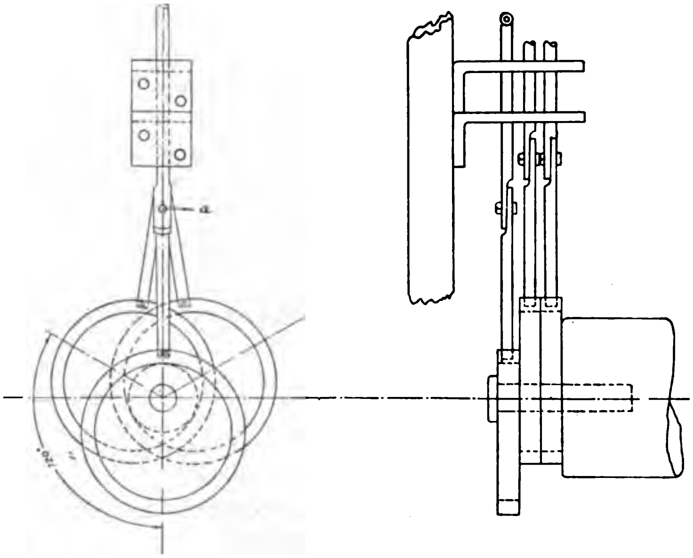
F 8

Reducing Gear for Gas Engine

The reducing gear shown in the print was adopted for a test made of some of the gas engines at the works of the Consolidated Gas Company in 1904.

This reducing gear was adopted for a test because it embodied the essential requirements for simplicity, durability and accuracy. In reproducing the motions of the pistons to a small scale, the eccentric diameters were placed at an angle of 120 degrees apart, and their throw made to equal the length chosen for the card.

Knowing the stroke of the engine, the length of its connecting-rod, and the desired throw of the eccentric, the length of the eccentric connecting-rod was readily determined; thus the movement of the point *a* would be exactly proportional to the movement of the piston.



DIAGRAM

The three eccentrics were rigidly fixed to a small shaft screwed into the centre of the main shaft. To the end of the connecting-rod was attached a slide rod, which passed up and down through two wrought-iron guides firmly screwed to an upright beam extending a little beyond the top of the engine. To the small eyebolts soldered into the end of the slide rod were fastened the steel wires leading to the indicator drum. At the end of the upright beam were fixed three small brass pulleys directly opposite the indicator, through which were passed pig-skin belt lacings connected to the steel wire, thus avoiding any breaks by wearing and jamming.

The steel wire then passed directly to the indicator, making an angle of 90 degrees with the vertical; and the end was fastened by means of a rubber band, thus taking up the slack. The above reducing motion was made at the time of the test, and proved very satisfactory throughout the five runs.

PHILIP F. BALLINGER, Long Branch, N. J.

F 9

Producer Gas Made in a Water-Gas Set

A seven-foot six-inch water-gas set, which did not happen to be in use at the time, was converted into a producer, and the producer gas generated was used for a gas engine which was belted to electrical apparatus. It was not convenient to use the air blast from the blower connected to the water-gas apparatus, and a No. 6 Koerting steam blower was tapped on to the generator at the bottom, and air and steam applied through it. The gas was taken off through the carbureter, superheater scrubber and producer and thence to a special pipe run to a holder, where it was stored. The average make per hour on this apparatus was 19,684 cubic feet, and the net calorific value of gas was 129.9 B.t.u. The following is an analysis of the gas: CO^2, 8.8; O^2, .2; CO, 22.5; H^2, 20.8; N^2, 47.7. Total, 100.

The generator worked against a holder pressure of five inches of water. It was coaled up every two hours and cleaned once every twenty-four hours. It was found necessary to keep the stack valve on the apparatus closed while coaling up, in order to prevent explosion in the carbureter and superheater. Gas-house coke was used as fuel.

WM. BANG, Long Branch, N. J.

F 10

An Emergency Repair for a Broken Pump Cylinder

At a substation in this city the Elmira Water and Railroad Company had a 1,000,000-gallon Knowles pump, used only in case of a breakdown or accident to main-line pump. During the month of January, 1904, the company was obliged to start the pump, but upon getting up steam it was found that the water cylinder head was broken. The main-valve cut-off had leaked and allowed water to enter the cylinder, which had frozen and broken the casting. It was necessary to start the pump inside of eighteen hours in order to keep up supply. Repair parts could not be obtained in time, so the broken pieces were glued together and bound with wire, and then a concrete filling was laid around the water cylinder to a depth of four feet. Upon starting the pump again it was found that there was still a small leak. We then procured twenty-five cents' worth of bran and put same in through hand-hole. This swelled and effectively stopped all leaking, and the pump was running in good order within the eighteen-hour limit.

O. N. BUNDY, Elmira, N. Y.

F 11

Making a Pump Lift Hot Water

Hot water, even up to 180 degrees F., may be lifted about 10 or 11 feet if the following piping is run: At the point where the vertical riser from the well meets the horizontal suction pipe to the pump an elbow would ordinarily be used; instead of the elbow use a tee, on the run of the tee extend the vertical pipe for about four feet and cap it over. This will do the trick.

H. C. HALL, Fall River, Mass.

F 12

An Indicator Device

Where considerable work is done in indicating engines in isolated plants, *et cætera,* a guide, partly for the indicator card, made as follows, will be found useful:

A clamp to fit the indicator piping is mounted on the end of a piece of half-inch pipe 24 inches long; a small pulley is mounted on a block that slides on the pipe and is fastened with a set screw. This can be quickly fastened to the indicator piping, which is necessarily on the cylinder, and for any position of the reducing motion the card can be adjusted so that it is in line with the cylinder. This will be found very handy when many engines are indicated.

J. F. DOSTAL, Denver, Colo.

F 13

A Cheap Vacuum

An artesian well with a good head of water is very valuable for condensing purposes. We have had such a well in use for the past ten years, and at present we are still using it. The well is an eight-inch well, bored on the banks of the San Antonio River, immediately back of the plant. It has a pressure of 15 pounds at the mouth of the well, and the head water, if measured above the water level of river, is 49 feet. This is sufficient head to carry the water to a Buckley condenser, injector type, which is placed on the roof of the plant. After the water does its work the greater part of it—that is, the overflow of the hot wells—flows away into the river, nothing being lost by this waste of water.

It is a valuable asset, for it needs absolutely no attention and repairs. Besides, it saves the first cost and maintenance of pumps and steam to run these pumps, also the cost of water and cooling towers, if the water had to be purchased. Among the other good features that the well presents is that it needs no attention that pumps would require, always giving us a steady stream of water, and we never need fear a "lost vacuum" for lack of water.

G. H. CUSHMAN, San Antonio, Texas.

F 14

Detecting a Poor Vacuum

The vacuum on a compound engine was noticed very low. All stuffing boxes were repacked, suction pipe and pump examined. candle test was made for leaks, but nothing found. By turning steam pressure on exhaust pipe between engine and condenser a number of very small leaks were found; these were too small to be found with candle test, but were in the aggregate sufficient to impair the vacuum. A new length of pipe was the remedy and fixed things O. K.

H. C. HALL, Fall River, Mass.

F 15

An Approximate Method of Metering the Boiler Feed Water

We experienced a good deal of trouble with the water-meter used to measure our feed water, until one day we had to discard it altogether. To keep tab on the water used, an old integrating watt-meter counter was rigged up with a ratchet and pawl on the last dial, and fitted on our feed pump so as to go forward one division for every stroke of the pump. From the size of the plunger and stroke one can calculate the amount of water per stroke. The leakage coefficient of the pump has to be determined, and this is often very hard to get at accurately. However, from observations taken, this coefficient was found to remain practically constant, and, at the worst, with the above outfit you can get a very good comparison of the feed-water consumption from day to day.

L. Denis, Montreal, P. Q., Can.

F 16

Scheme to Avoid Lifting Feed Water

A represents deep well; *B*, an electric pump; *C*, a pump; *D*, a steam pump for pumping water from *C* to tank *H*, on roof of boiler house; *G*, closed feed-water heaters; *F*, open feed-water heater; *E*, boiler-feed pump; *M*, batteries of boilers; *K*, old line to tank on roof; *J*, new line running from *D* to *O*, the outlet pipe from supply tank.

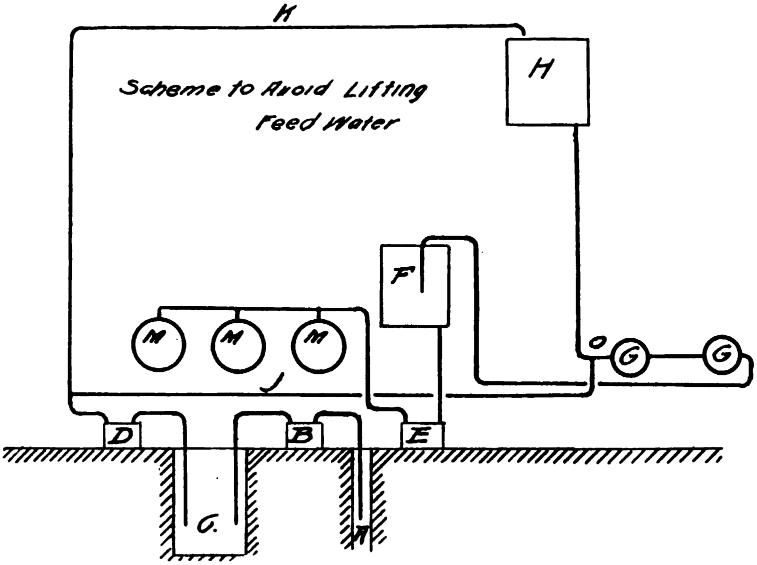


Diagram of Connections

The feed water is pumped direct from *D* to *G* through *J*, while formerly it was lifted to *H*, a vertical distance of 60 feet. Now only the excess water is lifted to supply tank. Heat is also saved, as water in *C* is heated to some extent.

B. E. Buttles, Denver, Colo.

F 17

Operating Engines Condensing When Short of Water

The steam plant in connection with the Quebec-Jacques Cartier Electric Company is used as an auxiliary in case of trouble or breakdown at the water-power plant in summer-time, and to help out the latter regularly in winter, when the load on the plant increases considerably.

The diagram shows the arrangement and piping of our water tanks. Under ordinary conditions the cold-water tank is supplied from the city main through a pipe—which is not shown—and the hot well is allowed to overflow into the drain pipe. The boiler-feed pump is supplied from either the hot well or the cold-water tank by opening valve *A* or valve *B*.

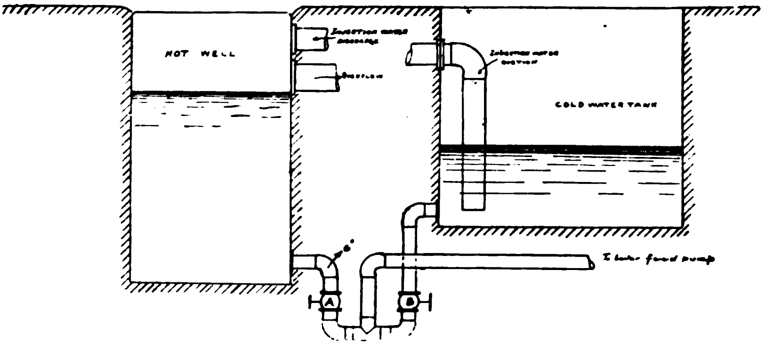


Diagram of Connections

On the particular occasion referred to, the city unavoidably had to shut off the water for a whole day to repair a leak, and it was up to the steam plant to run at least one 500-hp set to help out the water-power plant. The tanks were practically full, and it was thought at first to run non-condensing, but, even then, we should not have had water to run more than three or four hours.

So the following plan was tried and found to work remarkably well:

A condenser pump was started as usual, and the feed-pump piping had valve *A* open and valve *B* closed. The water in the cold-water tank was allowed to drop about one foot below the level of the overflow in the hot well, then valve *B* was opened. The difference of level between the two tanks allowed the water to flow from the hot well to the cold-water tank through the feed-pump piping, thus, practically, losing no water. The only thing remaining to be done was to keep the water in the cold-water tank cool. This was done by keeping the tank well provided with snow, which we had in plenty, but it kept two men and a rig busy carting. The melted snow more than overbalanced the water lost through leaks or otherwise, and this plan could have kept us running almost indefinitely, as long as we could have been kept supplied with snow or ice.

L. Denis, Montreal, P. Q., Can.

F 18

Hot Feed Water

Our electric equipment consists of six Corliss condensing engines and one DeLaval turbine. The condensing water is of such a quality as to be unsuitable for feed water, even though a suitable separator were used to take out the oil. We are contemplating installing a jet condenser on one turbine and using our regular boiler-feed water in it for condenser water. As there is no oil introduced into the water it can be used for boiler feed, heating it up to a certain degree before passing it through the regular feed-water heaters. With this arrangement the condenser may be made to fulfill two uses—that of a condenser and of a feed-water heater.

C. W. Humphrey, Denver, Colo.

F 19

Receiver Steam to Heat Boiler Feed Water

In case the exhaust steam does not heat the feed water sufficiently, we have found a gain can be made by admitting steam from receiver of compound-condensing engine direct to heater.

B. E. Buttles, Denver, Colo.

F 20

Increasing the Heat of Feed Water

In the vertical header type of horizontal water-tube boilers, the iron doors on the rear end of the setting radiate a great quantity of heat; by taking a lot of old pipe coverings of magnesia, *et cætera,* that was not fit for re-use on the pipes, breaking it up and mixing it with water, then baking in short pieces of I beams for moulds, we made a number of slabs, which were fastened to the inside of the doors; this saved a lot of heat, and as economizers are used the increase in the temperature of the feed water was noticeable.

H. C. Hall, Fall River, Mass.

F 21

Stopping Air Leaks in Boiler Settings and Doors

Packing cracks in brickwork and around door frames with asbestos wicking will materially reduce the amount of cold air going through, and will, if economizers are in use, help to raise the temperature of the feed water.

H. C. Hall, Fall River, Mass.

F 22

Turbine Boiler-Tube Cleaners

As usually made, the cutters are so far in advance of the turbine that removing scale from the extreme end of the tube is difficult, as the cutters begin to cut about a foot from the end; making an extension piece to fit the tubes, so as to practically lengthen the tube a foot or more, solved the problem of how to make the cutters work on the extreme end of the tube.

H. C. Hall, Fall River, Mass.

F 23

Equalizing Heat in Steam-Heating Risers

In a steam-heating system it was found that some risers were getting more steam than others; on account of being piped with Tees instead of Y's; a plug with a small hole drilled through it, inserted in the riser getting the most steam, will choke part of it off and send more through the other pipes, and so equalize better.

H. C. Hall, Fall River, Mass.

F 24

Grinding In Seats of Safety Valves

It is sometimes necessary to grind in the seats of safety valves without disturbing the set of the spring; after taking off the lock, cap and test lever there are usually found two nuts for the fork of the test lever to lift valve from seat; when testing valve with boiler under steam, by inserting a piece of pipe between head bolt and these two nuts, and clamping the pipe tight, we can then take off the bonnet without disturbing the set of spring and grind in the valve. H. C. HALL, Fall River, Mass.

F 25

A Space and Power Saver for Belted Units

In the central station of the Elmira Water, Light and Railroad Company two Westinghouse 200-kw, 500-volt, direct-current machines were connected up as shown in diagram *A*. A line shaft was belt-driven by a 500-hp triple-expansion McIntosh & Seymour vertical engine, and the two dynamos were belt-driven from line shaft.

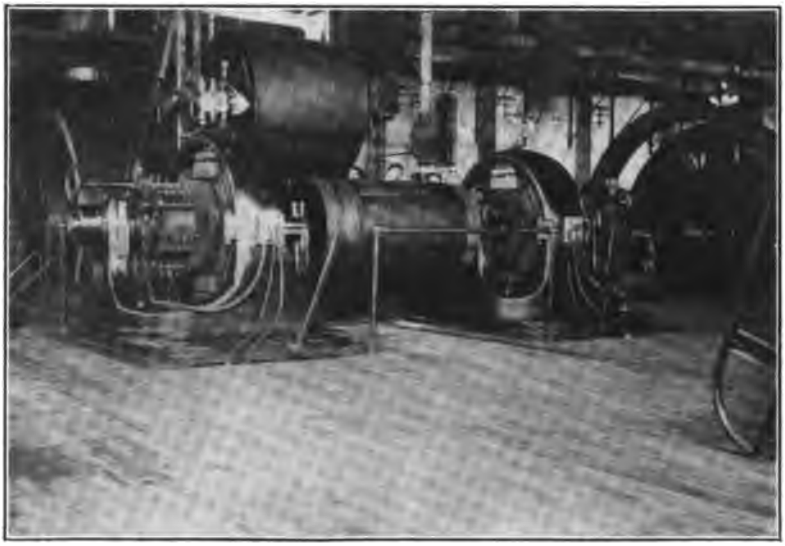


FIG. 1

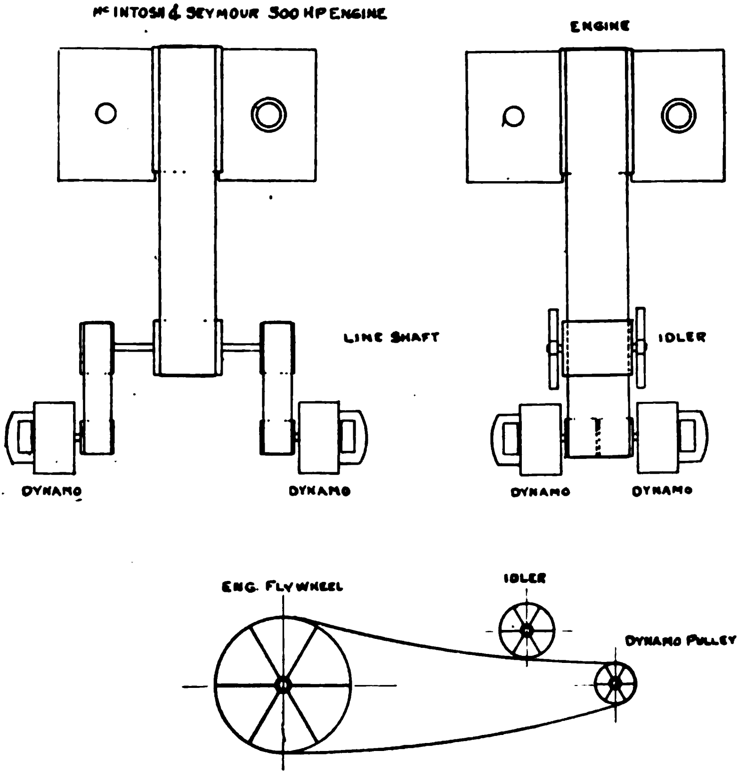


FIG. 2—PLAN OF APPARATUS

In order to economize space and save power the two dynamos were connected up as shown in diagram *B*. They are not connected together, but the single large belt from engine laps over on both pulleys, which are about one-half inch apart. The idler serves to take up slack in belt and also gives belt more pulling space on dynamo. In addition to the floor space gained, it was found that there was also a saving of 25 horse-power, which was used to run line shafting.

O. N. BUNDY, Elmira, N. Y.

G

GENERATORS, STATION INSTRUMENTS, ETC.

G 1

To Maintain Approximately Constant Voltage When Throwing One or More Generators In or Out When Operating in Parallel With a Generator Having the Same Source of Exciting Current

As the exciters here are driven by a small, independent turbine, we have found that in switching on the field-current of a second generator, though with all rheostat resistance in circuit, a very objectionable disturbance is made in exciter speed and voltage, and, in spite of the best possible switchboard attendance, in the voltage on first generator. Besides this, we consider that in the case of having the second generator connected to a separate line and sets of transformers, it is objectionable to have so large a percentage of full voltage, as is thus obtained, switched on suddenly.

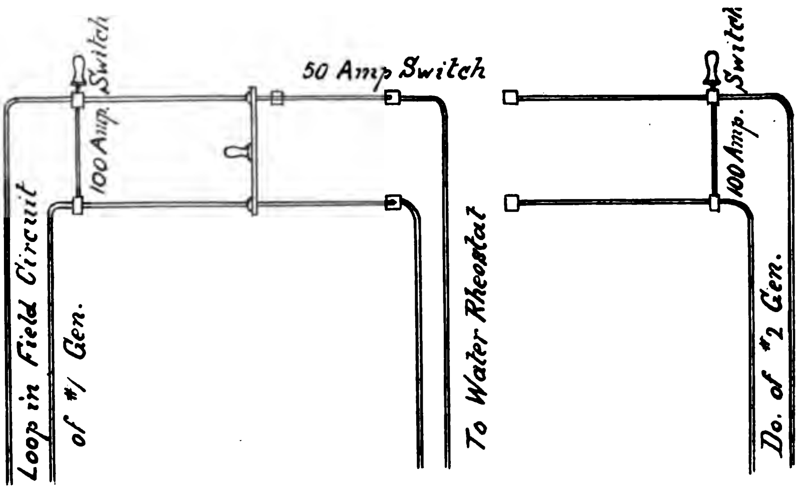


Diagram of Connections

To overcome this difficulty, we use a water-rheostat connected to a double-throw switch, as per diagram, so that it may be inserted in a field-circuit of either of two generators or be short-circuited. We thus obtain a very gradual rise in voltage from zero to normal, and a gradual decrease from normal to zero, in starting up, or closing down a second generator, line, and set of transformers, without objectionable disturbance of voltage on first unit, and with a minimum of potential strain on second outfit.

G. HARTMAN, St. Gabriel, P. Q.

G 2

A Method of Repairing Damaged Insulation Between Damaged Commutator Bars

A commutator trouble that sometimes worries the operators of direct-current generators and motors is a short-circuit between adjacent commutator bars, which gradually burns down deeply into the mica insulation, and ends eventually in a burn-out of a section of the armature winding. The trouble may disappear for a short time if the burned insulation is scraped away, but carbon dust from the brushes soon accumulates and bridges across from bar to bar, and the difficulty continues.

A permanent cure may be effected by digging out all the dirt and burned mica and filling the cavity with a thin paste composed of litharge and glycerine. The commutator should then be heated at this point with a soldering iron or blow torch, baking the paste to a hard compound, which can be filed off smooth and even with the commutator surface.

It is very essential to absolutely remove the short-circuit before applying the paste, and it is best to disconnect one of the bars from the armature winding and test across the insulation, using a voltmeter or incandescent lamp as an indicator. Holes three-quarters of an inch deep have given no trouble since receiving this treatment.

CLEVELAND ELECTRIC ILL. CO.

G 3

Protecting Standard Indicating Instruments

Primary indicating standard instruments used for checking working standards on meter test racks are in one instance well protected from stray magnetic fields and from mechanical injury, by being supported each inside of an iron box over 30 inches square. The boxes are made of boiler plate, welded seam, top and bottom bolted tightly to side wall. A wooden partition horizontally through the box gives support for the instruments. Low-candle-power electric lamps, inside the boxes, light the instrument scales. A rectangular cardboard tube painted a dull black, extending from slightly over the instrument scale to a slot in the top of the box, eliminates reflection and protects the eyes of an observer from the rays of the lamps. The boxes are mounted on castors for ease in moving to switchboard type working standards to be checked.

CLEVELAND ELECTRIC ILL. CO.

G 4

Handy Galvanometer for Potentiometer Work

For some time we were bothered to get a galvanometer for use with a potentiometer in a location where there was too much vibration for a D'Arsonval suspension galvanometer. The ordinary small pivot galvanometer was not sensitive enough for the work. We obtained a student's miscroscope, removed the mirror and table, and put an extension on so that the lenses could be brought over a pivot galvanometer. With this arrangement, which is always ready for use regardless of ordinary vibration, we can use the potentiometer for measurements to two-thousandths of one volt.

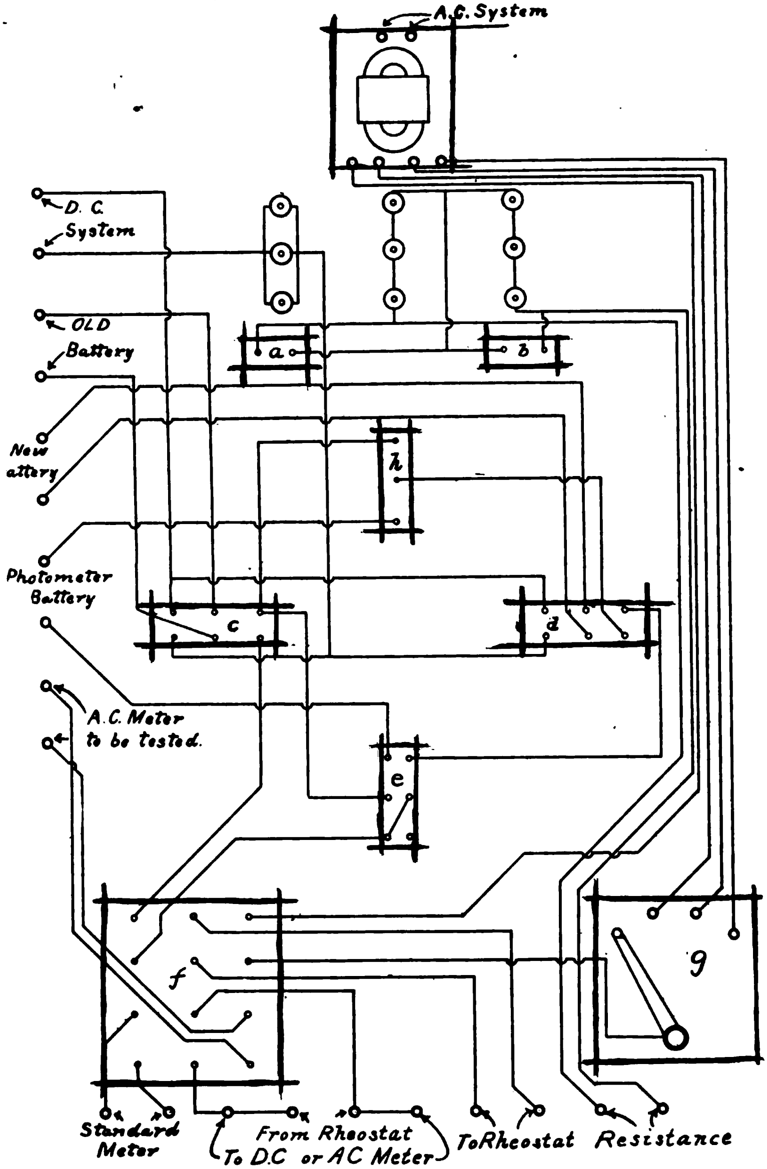
C. R. BROWN, Boston, Mass.

G 5

Switchboard for Voltmeter Testing

The accompanying diagram shows the connections of a switchboard used in connection with voltmeter testing in the laboratory of the Edison Electric Illuminating Company, of Boston, which embodies several features that have proved very useful in facilitating rapid work.

Three batteries are used as shown on the left of the diagram. The posts labeled "D. C. system" are for a 220-volt charging circuit for two of the batteries. Double-pole, double-throw switches, *c* and *d,* when thrown to the left charge the "old battery" and "new battery," the other battery being charged from another



SWITCHBOARD CONNECTIONS

board. When thrown to the right they put the batteries at the service of the operator. The two posts marked "standard meter" connect with a direct-current standard voltmeter; an alternating-current standard may be put in on the two posts marked "D. C. or A. C. meter." The posts marked "to rheostat" are connected to the outsides of two rheostats placed in series, one having a resistance of 1500 ohms in 30 steps, and the other having a resistance of about 100 ohms in very small steps for fine regulation. The insides of these rheostats are connected to the posts marked "resistance," which, it will be noted, connect with switches *a* and *b*, so that three or six 16-cp, 110-volt lamps may be thrown in series with, and between, the two rheostats. The moving arms on the rheostats are connected to the posts marked "from rheostat." The switch *g* is connected to the potential transformer at the top of the board. This is fed from a 110-volt circuit, and the secondary taps give 150, 300 and 600 volts, respectively, from left to right as connected to *g*. Just below the transformer are three sets of three 16-cp incandescent lamps. The left-hand set is in multiple and is used in charging the batteries; the other two sets have been referred to already.

In checking a voltmeter the procedure is as follows: To get 110 volts, switch *c* is thrown to the right, the meter connected to the posts as indicated, and the rheostat removed to the required point to give 110 on the standard, which is a direct-current meter. Here switch *e* is down and *h* up. If we wish 220, *d* is thrown to the right, *e* is thrown up and either *a* or *b* opened to protect the rheostat against overload, and the rheostats adjusted to the proper point. For 600 volts, switch *h* is thrown down and *a* and *b* are opened. In all direct-current work switch *f* is thrown to the left. A reversing switch in the line to the meter to be checked will be found useful.

This board lends itself very well to the checking of alternating-current meters, using a hot-wire meter as a standard. This may be connected to the posts marked "to D. C. or A. C. meter" and the alternating-current meter to be checked connected to the posts on the left near the battery posts. The hot-wire meter may be set anywhere by the method given for direct-current meters, and then by throwing *f* to the right everything but the direct-current standard is cut over to alternating-current, and the transformer switch *g* can be set to give approximately the same voltage as the batteries in use.

C. R. Brown, Boston, Mass.

G 6

An Improvised Voltmeter Multiplier

An occasion came up some time ago to measure a 370-volt circuit; no voltmeter of sufficient capacity was at hand. A 150-volt voltmeter was connected in series with the resistance box of a Wheatstone bridge, and plugs were pulled out until the resistance was twice that of the voltmeter, the voltmeter thus indicating one-third the applied voltage. These standard resistance boxes are wound non-inductively, and can be used in connection with either direct or alternating currents. It has also been used to increase the range of indicating wattmeters and is very handy, since any degree of multiplication can be obtained.

J. F. Dostal, Denver, Colo.

G 7

An Ohm-Meter

The instrument here described, we find to have considerable advantage for any approximate tests to determine resistance; for example, meter armatures, meter compensating coils, arc-lamp shunt coils, *et cætera*.

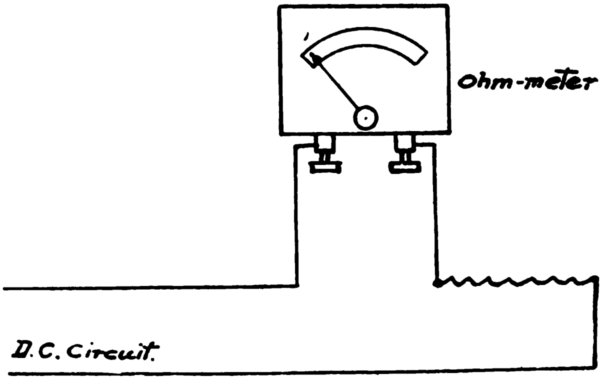


Diagram of Connection

It consists of an old voltmeter with its scale calibrated to read in ohms instead of volts.

In the diagram it will be seen that the resistance, *r*, the value of which we desire to learn, is placed in series with the voltmeter, and of course reduces the deflection by an amount proportional to the magnitude of *r*.

We effect the calibration of the instrument by using a Wheatstone bridge and plugging out the desired values of *r*. For approximate work it is a great time-saver over the use of the bridge.

S. R. INCH, Missoula, Mont.

G 8

Testing Direct-Current Meters by Use of Electroplating Dynamo

In testing direct-current meters on various loads, we have found it very satisfactory to use an electroplating dynamo, with capacity of 150 amperes and five volts. The terminals of this dynamo are short-circuited through the series coils of the meter, and a resistance in the shunt windings of the field governs the load. One side of the regular line is connected to one terminal of the dynamo, and the other is connected to the regular shunt connection of the meter, thus giving the required voltage across the shunt on the meter. The electroplating dynamo is run by a single-phase induction motor. By this method we are able to get any desired load up to 200 amperes by taking comparatively little load off the line.

THOMAS S. RICHARDSON, Denver, Colo.

G 9

Testing Armatures for Open-Circuit Coils in Thomson Recording Wattmeter

Use an incandescent lamp of approximately 16 candle-power and 110 volts alternating current in series with a relay, and these in series with the coil being tested. If the circuit is complete the vibrations of the armature will indicate it. Saving in time and increased facility in making this test are considerable when a number of meters are in the repair department. This may be practiced by some companies, but I know it is not universally applied.

THE WILMINGTON CITY ELEC. CO.

G 10

A Cheap and Convenient Oil Fuse

An ordinary General Electric primary cut-out, inverted and filled with oil, makes a very good oil fuse for moderately high voltages.

H. S. Russell, Denver, Colo.

G 11

A Handy Light for Night Testing

A handy arrangement for reading instruments at night, when testing transformers and locating trouble, was made by taking an incandescent lamp out of a Christmas-tree set and fastening to a swinging bracket mounted on a lap board large enough to hold the instruments and record book. The current was supplied by twelve dry cells connected in series and mounted in a box carried in the bed of the wagon and connected to the lamp by lamp cord. This set has been in use for several months, and the batteries do not run out like those of the hand flash-light sets.

J. F. Dostal, Denver, Colo.

G 12

Interconnection of Feeder Systems

In remedying the chaotic condition of affairs in Schenectady by placing the feeders in the business portion underground, we have been compelled to so connect our various feeders that one feeder may furnish current for the one adjoining it in our system of distribution. This was made necessary by the fact that the system of feeding from our old station was overhead, while the system at our new station was underground. It became necessary to start our new station before our underground system was completed, and we were therefore compelled to place current on our primary underground feeders in order to supply our overhead system from the pole taps carried in the cable boxes at various locations.

After we had completed the connections between our primary, three-phase underground and overhead feeders, and had placed them in operation, we began to interconnect our overhead system by carrying the three phases of the overhead system from some point near the cable box to some point accessible to the three-phase overhead system of an adjacent feeder in our system of distribution. These interconnecting leads were in some instances a part of one of the two feeder systems to be connected, and in most cases it was only necessary to run a third wire and extend our single-phase lighting primary in order to give us this three-phase accommodation.

Where the two feeder systems were brought together we used an expulsion type of fuse box, testing out the leads to be placed in these fuse boxes with a potential transformer in order to bring the proper phases of the two feeders into the same fuse box. As the drop in our feeder system during the day is very slight, we cut out our feeder regulators, the voltage on all feeders being practically the same. By this arrangement you will notice it was possible for us to feed our overhead system of distribution from an adjacent feeder during the time of light day load by plugging in the fuses mentioned and pulling off the underground feeder from any given section from which we desired to work. This has made it possible for us to make our proper primary underground taps and connections, and develop our underground system and still continue feeding from our new station.

In the business sections of the city we continued to supply current from our overhead secondary, which in turn was supplied with current from our overhead primary, which received its current in turn from the underground primary system. Each day we fed this overhead system from an adjacent feeder and cleared the underground primary feeder in the business sections, thus being able to continue work regularly on our underground system of primary and secondary feeders.

As all of our feeder systems are fed from one common 2300-volt, three-phase 'bus, it made it possible for us to place these feeders in multiple by testing out the phase with a potential transformer of about 50 watts capacity, using a lamp on the secondary of the same. We find this a much better and safer method of phasing our lines than the old method of using a long piece of fuse and a stick.

L. O. Ripley, Mgr. Schenectady Illuminating Co.

G 13

Two-Phase, 400-Volt Service from a Four-Wire, Three-Phase System

In a case where service was desired by the owners of an isolated plant, which had broken down, the following method of rendering 400-volt, two-phase service from a four-wire, three-phase system was employed:

It being an emergency case, and the load being approximately 400 kilovolt amperes, it was necessary to accomplish the result by the use of eight 50-kilowatt standard lighting transformers, four of which had a ratio of 10 to 1, with 208-volt secondaries, and the other four a ratio of 9 to 1 with 230-volt secondaries. Following the usual Scott system of transformation from three-phase to two-phase, the scheme of connections shown in Figure 1 was worked out on the basis of using two transformers in series on both primary and secondary. The normal primary voltage being 2080 from neutral to either phase wire, and 3600 between the phase wires, it was necessary to use two 2080-volt windings in series on the primary side. The voltage of the motors being 400, it was likewise necessary to connect the secondaries in series. In order to secure approximately 400 volts on each of the secondary phases, it was necessary that the primary pressure be about 4160. The pressure was obtained by inserting boosters in the three-phase line.

After connecting the transformers as shown in Figure 1, voltmeter readings were taken without load. These readings indicated approximately 400 volts on the transformers between the *A* and *C* phases, but a somewhat lower pressure on the transformers connected from the *B*-phase to the mid-point between the other two transformers. Upon attempting to start a 5-hp motor, the voltage on the vertical phase fell back almost to zero, while that on the horizontal phase was but very little changed.

On connecting a separate transformer from the mesh point *O* to the three-phase wires *A, B* and *C,* respectively, it was found that the point *O* assumed a position about equivalent to that represented at *O'* on the small diagram. It was therefore impossible to render any service with this scheme of connections.

A theoretical analysis of the phenomena involved seemed to indicate that the trouble was due to the fact that the current which

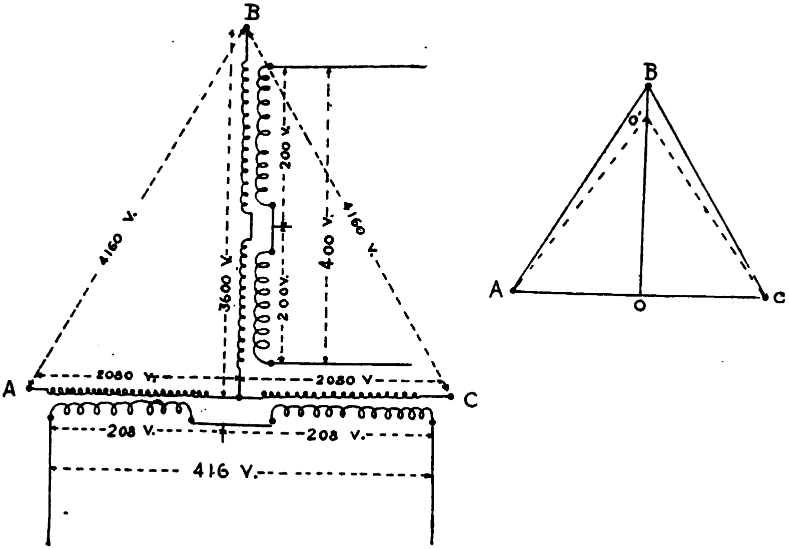

B
4160 V.
3600 V.
200 V.
200 V.
400 V.
4160 V.
A
2080 V.
2080 V
C
208 V.
208 V.
416 V.
B
O
A
O
C

FIG. 1

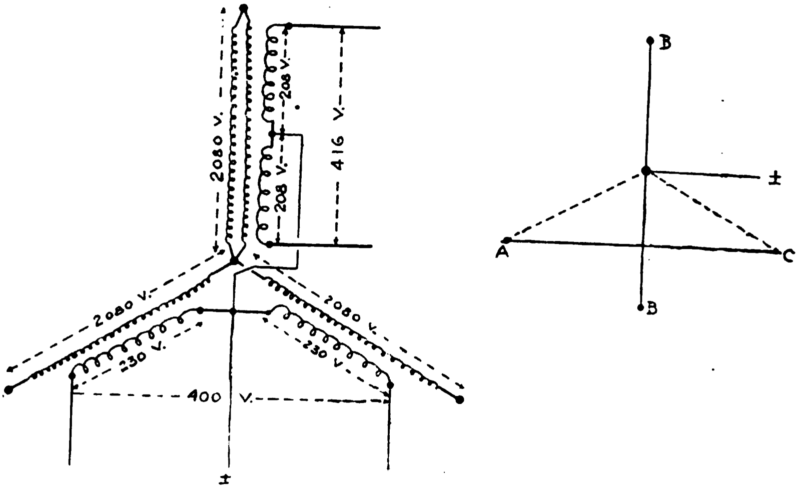

2080 V.
208 V.
208 V.
416 V.
2080 V.
2080 V.
230 V.
230 V.
400 V.
±
B
±
A
C
B

FIG. 2

passed from the *B*-phase to the *A* and *C* phases was choked by the impedance of the two transformers connected between *A* and *C*. These transformers offered an impedance to this current because of the fact that their windings were not on the same magnetic circuit, as is the case in the usual method of phase transformation.

It was therefore necessary to adopt the scheme of connections shown in Figure 2, in which the two 10 to 1 transformers were connected in parallel from *B*-phase to the neutral wire of the four-wire line, and the two 9 to 1 transformers were connected from the *A* and *C* phases, respectively, to the neutral. The secondaries of the *B*-phase transformers were put in series to get 400 volts and the 230-volt secondaries of the other two were combined in a similar manner. The primary voltages were such in this case that it was unnecessary to install boosters, which would have been required in the other scheme of connections. This

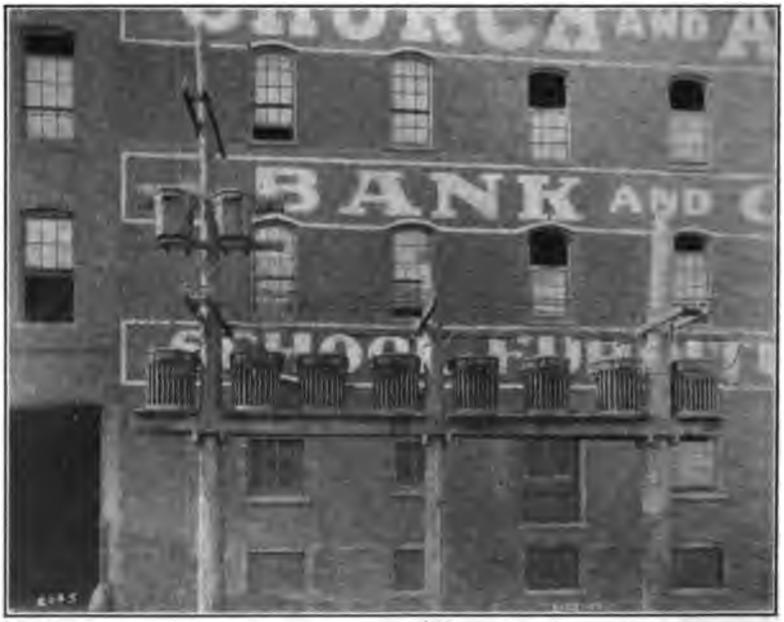


FIG. 3—TRANSFORMERS IN PLACE

scheme, however, unbalanced the three-phase line in the following ratios:

A	57.7 amperes
B	100 amperes
C	57.7 amperes

The company supplying current not being provided with meters designed for 440-volt service, the mid-points of the two-phase windings were tied together, as shown in the small diagram in Figure 2, and the secondary neutral thus formed was carried into the building to act as a pressure wire for the meters. Two sets, consisting of four 50-kw transformers each, were connected as shown in Figure 2 to carry the load.

The installation was mounted on a platform 15 feet above ground, which was supported on three poles placed about 12 feet apart, the entire work of setting poles, mounting transformers and extending primary line 500 feet being finished in about twenty-four working hours.

H. B. GEAR, Chicago, Ill.

H

STORAGE BATTERIES

H 1

Method for Bracing Wooden Tanks of Storage-Battery Cells That Have Rotted Out at the Corners

Large porcelain insulators, such as are used for indoor wiring, were driven in between cells where wood had just started, and if necessary wedged in place by thin wooden wedge. Tanks braced in this manner are insulated from each other, as would not be the case if wooden wedges alone had been used.

CLEVELAND ELECTRIC ILLUMINATING CO.

H 2

Storage-Battery Test of Materials for Protecting Copper 'Bus Work in Battery Rooms

Strips of sheet copper about 0.75 inch wide and six inches long were coated with protecting material to be tested and suspended in a bath of sulphuric acid (1.2000 specific gravity) so that they were only partially immersed in the acid. A portion of the upper part of strip was purposely left bare to observe effect of acid fumes.

After remaining in the acid for one month the strips were removed and examined.

Their condition was as follows:

(a) Strips coated with vaseline; showed no signs of corrosion or sulphating. Coating in as good condition as when first applied.

(b) Strip coated with tar; was in the second-best condition of any strip, as no sulphate was formed on that part of the strip not immersed in the acid, but one edge of the immersed portion was sulphated about one-third of its length.

(c) Strip coated with shellac; was third best; one edge, however, had peeled off, allowing the acid to attack copper. A portion of the unprotected copper about one-half inch wide was badly sulphated.

(d) Strip coated with paraffin; most of the immersed portion of the strip was not sulphated, but from one-half inch below the surface of the acid to the top of the strip was badly sulphated.

(e) Strip coated with graphite paint gave results similar to paraffin.

(f) Strip coated with heavy, viscous petroleum cylinder oil; badly sulphated entire length.

Vaseline was the only substance that stood the test, but is not entirely satisfactory as a protective on account of its pasty nature.

Experiments were carried out with mixtures of vaseline and paraffin, the latter substance acting as a hardening material. It was found that if over 30 per cent by weight of paraffin was used the coating cracked slightly and did not adhere properly to the copper. 'Bus work was painted with mixture of 20 per cent paraffin and 80 per cent by weight of vaseline, and after three months' use the coating is apparently as good as ever. Dust and moisture can be removed by a soft cloth without injuring coating.

CLEVELAND ELECTRIC ILLUMINATING CO.

H 3

Recharging Flashlight Batteries

In our meter-readers' room are terminals of the 220-volt direct current, with three 50-cp, 110-volt incandescent lamps in series for recharging batteries.

By placing the battery across these terminals for one or two minutes it is then ready for service again. This prolongs the useful life of the battery at least 100 per cent, in this way cutting down the maintenance on flashlights to a considerable extent.

H. S. Russell, Denver, Colo.

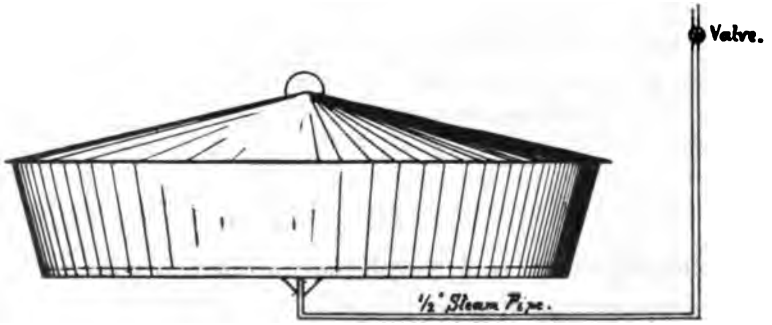
I

MISCELLANEOUS

I 1

Soiled-Waste Cleaner

I think the drawing of a soiled-waste cleaning arrangement, which I have found very good in my plant, will explain itself.



Waste Cleaner and Connection

We use a galvanized tub to which is connected a half-inch steam pipe, and when the dirty waste is put in we mix with it a box of pearline; after it has boiled for a few hours the waste is taken out and run through a clothes wringer, which puts it in very good shape for use.

I do not know whether this is a novel scheme or not, but I offer it for what it is worth.

A. R. Smith, Demopolis, Ala.

I 2

Cleaning Waste and Rags

We separate out all the oil and a portion of the dirt in the waste and rags by means of a centrifugal washing machine. A machine of this type can soon be made to pay for itself, which we have found out from actual use.

G. H. Cushman, San Antonio, Tex.

I 3

The Washing of Waste and Wiping Cloths

About a year and a half ago we bought an oil press to press the oil out of waste, and after some experimenting we bought a small-sized washing machine, such as is used in a steam laundry, connecting it up with steam and water and running the same by the use of a 3-hp motor we had on hand. We now wash all of the waste and wiping cloths used by running the machine for about two hours once a week. We use a washing soap called "Takeanap," and some washing soda with it, and make quite a saving over buying new waste.

C. E. Inman, Warren, Ohio.

I 4

Installing Apparatus on Second Floor as Protection from Floods

In planning an alternating-current substation in a location subject to possible flooding from a nearby stream due to freshets it was found that a saving of 10 per cent in the cost of the building could be made by installing all apparatus on the second floor, approximately 12 feet above the street level, thereby saving the waterproofing that would be necessary if apparatus were placed on the lower floor.

Leonard L. Elden.

I 5

Single-Phase Commercial and Series and Incandescent Street Lighting from One System

It became necessary to supply single-phase commercial and series incandescent street-lighting service to a small suburban town a number of miles from the substation. The returns possible were so small that it was not profitable to install two wires for each circuit, and therefore three were installed, two of which were for the commercial single-phase service and the third for the street-lighting circuit, one of the wires of the commercial circuit being used for the return wire of the street-lighting circuit. The only disadvantage to this scheme was the fact that the street-lighting circuit was alive during the day, but this proved to do no harm, and, as it was necessary to work on the street lines, a switch was installed on a pole in the district supplied, which opened the street-lighting wire attached to the commercial circuit, thereby killing the street-lighting system and making it safe to work on.

LEONARD L. ELDEN.

I 6

Remedy for Blowing of Fuses on Overloaded Transformers

Two years ago eight 30-kw transformers were tied into a common secondary supplying the business portion of the town. One night during the peak of the load one transformer blew a fuse, thus throwing the load onto the adjacent transformers; these, in turn, blew their fuses on account of the additional load, and in less than a minute all eight transformers were out of service, leaving the business section of the city in darkness.

The next day circuit-breakers were put in on the secondaries between transformers, and no trouble has since been experienced. To save the drop in copper the various sections were tied together with 75-ampere fuses.

LEONARD L. ELDEN.

I 7

Method for Preventing Destruction of Lead Coverings of Cables at Drawbridge Crossings

A method used to prevent destruction of lead coverings of cables where they enter and leave the water at drawbridge crossings in locations where large quantities of direct-current railroad return currents are flowing in approximately the same directions as the cables are laid has been to install a large bare conductor, say 1,000,000 circular mils, in the water across the drawbridge or channel and bond it thoroughly to all the cables on each side of the channel at a point well above the water line of the highest tide. This has entirely obviated the relatively rapid destruction of the lead coverings of lighting and transmission cables from currents of the street-railroad company.

LEONARD L. ELDEN.

I 8

Broken Water Pipe—How to Fix Temporarily

I have found from experience that General Electric splicing gum, with a good covering of Acme friction tape, will hold a broken water pipe until it can be permanently mended.

F. M. LAXTON, Atlanta, Ga.

I 9

Thawing Water Pipes

In thawing frozen water pipes about the plant we have found that a one-inch galvanized-iron pipe is readily thawed by a current of 250 amperes, but a section of 1.5-inch pipe gave us trouble, as it required more current than we could safely supply with the means at hand.

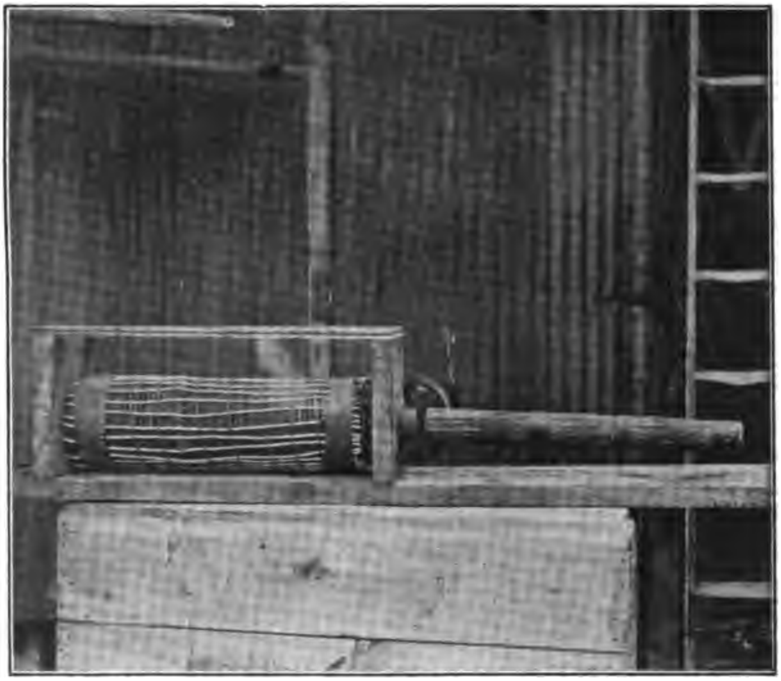
To furnish a conductor of higher resistance four No. 10 iron wires were wrapped in a one-sixteenth-inch asbestos sheet, doubled, bound to the pipe and the latter packed as before; in this case it was convenient to attach one end of the wires to the pipe and use it as a return. We can now thaw the pipe with about 100 amperes. The asbestos is sufficiently good insulation as regards electricity and a sufficiently good conductor as regards heat.

In using this method care must be taken that each wire carries its share of current and that the wires are not overheated; in any case it is wise to watch any combustible material about the pipe. G. HARTMAN, St. Gabriel, P. Q.

I 10

Reactance Coil for Thawing Frozen Water Pipes

The illustration herewith shows a "home-made" reactance coil that we have used with great success this winter.



REACTANCE COIL

There are 180 turns of No. 2 B. & S. gauge wire in the coil, wound with two No. 2 wires in multiple, so that, as generally used, the coil is equivalent to 90 turns of No. 00 wire. The wire is wound on a piece of wood stave pipe with a three-inch bore, and the core consists of a large number of pieces of No. 10 iron wire bound together with marline.

The total cost of this coil, material and labor was $8.00, and it gave us sufficient range to thaw out pipes varying from 0.75-inch to 4-inch with currents varying from 100 to 400 amperes. In nearly all instances two to five minutes were sufficient to thaw pipe.

S. R. INCH, Missoula, Mont.

I 11

Trimming Municipal Arc Lamps

We find a trimmer's cart drawn by a horse very economical, inasmuch as it requires only one man to trim our lamps, at the same time replacing all outer globes that may be broken, and cleaning all inner globes. The cart is so arranged that it will hold 100 inner globes and three outer globes. Our lamps are General Electric, Form 3, 6.6-ampere, series-alternating, furnished by 50-light tub transformers. From April 1 to November 1 the lamps require new trimming every seven days, and from November 1 to April 1, the nights being longer, they require trimming every six days. Hence the trimmer has to make a complete round on all circuits in seven days during the summer-time, trimming about 90 lamps per day, and during the winter-time trimming about 95 lamps.

The trimmer, having made his cart ready the evening before, makes his start at seven o'clock in the morning, completing his day's trimming in five to seven hours, then returning to the electric station and washing all the inner globes removed from the lamps, and putting them on the dripping rack to dry; then he takes the globes that were washed the previous day and puts on bottom-carbon holders and inserts bottom carbons. He then proceeds to arrange his cart ready for the next day's trimming.

R. A. HAMMACK, Montgomery, Ala.

I 12

To Prevent Inner Globes from Melting

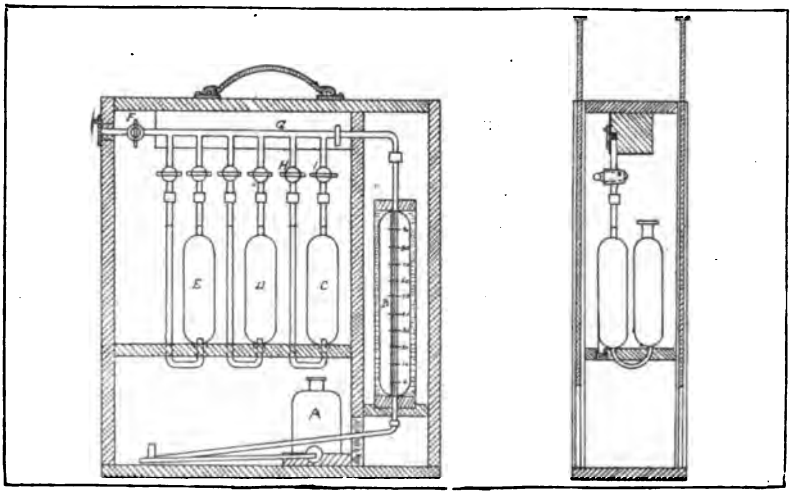
We had much trouble with the melting of inner globes on our arc lamps, and decided that it was due to the globes being too thin. We now use inner globes having a thickness of .09 of an inch, this thickness to show on top and bottom edges of the globes, and we now have practically no trouble from this cause.

P. C. Brown, Brookline, Mass.

I 13

An Apparatus for the Rapid Analysis of Flue Gases

The analysis of flue gases as ordinarily conducted with the D'Orsat or Hempel apparatus requires considerable time, if accurate results are to be obtained, so the apparatus presented here was designed to enable analyses to be made more quickly. The essential feature is the introduction of the gas in the re-agents in a finely divided stream at the bottom of the absorption pipettes, so that it bubbles through the liquid and consequently comes immediately into intimate contact with it.



A is the leveling bulb; *B* is the measuring tube which is water-jacketed; *C* is the first absorption pipette, in which caustic potash is used to absorb carbon dioxide; *D* is the second absorption pipette, in which potassium pyrogallate is used to absorb oxygen, and *E* is the third pipette, in which cuprous chloride is used to absorb carbon monoxide; *F* is the inlet cock; *G* is the header; *H* is the inlet cock to one of the absorption pipettes, and *I* is the outlet cock to one of the absorption pipettes.

The method of analysis is as follows: A sample of gas is drawn in through the cock *F*, along the header *G* to the measuring tube *B* by lowering the leveling tube *A*. A little more than 100 cubic centimeters are taken in. The leveling tube *A* is then raised so that the water in it is even with the zero mark on the measuring tube *B*, and the cock *F* is open for an instant, so that the gas in the tube *B* comes to atmospheric pressure. The cock *F* is then closed, and the tube *B* contains 100 cubic centimeters of gas at atmospheric pressure. Cock *I* is then opened, and the bulb *A* is slightly raised, so that about three cubic centimeters of gas is transferred to the pipette *C*. This is done to clear the capillary tube at the top of *C* of the re-agent. The cock *I* is then closed and the cock *H* is opened and the rest of the gas bubbled in through it at the bottom of the pipette. When the gas is all in, the re-agent is drawn back into the capillary leading from the bottom of *C* to *H*, and the cock *H* is closed. The cock *I* is now opened, and the gas is drawn back through it into *B* by lowering *A*. The cock *I* is then closed and the gas in *B* measured in the usual way. This operation is repeated in the pipette *C* until there is no further absorption. The gas is then transferred to *D* and *E* and the same process repeated.

If care is taken at the close of each analysis to see that the cocks are greased with vaseline, there will be no trouble from the tendency to stick, which has been frequently advanced against the use of glass cocks in gas-analysis apparatus.

W. B. TUTTLE, Long Branch, N. J.

I 14

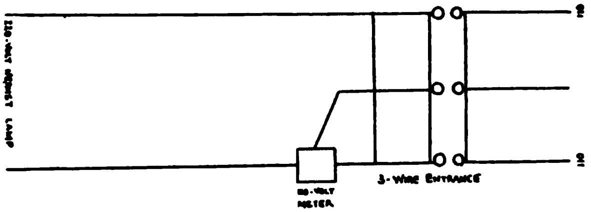
Recording Voltmeter on Electrolysis Survey

In taking a series of measurements for current flowing in gas or water mains, and of pressures between car track and mains, it is desirable to have a continuous record of the pressure between track and main at some particular point for reference and comparison. A Bristol recording voltmeter may be used for this purpose. A resistance may be inserted, such as to bring the record in a convenient part of the scale, and the instrument recalibrated with this resistance.

J. M. WEED, Denver, Colo.

I 15

Using a 110-Volt Meter on 220-Volt Circuit



110—VOLT METER AND CONNECTIONS

Enclosed find rough sketch of scheme that works all right when you want to meter a load on a 220-volt circuit, and have nothing but a 110-volt meter in stock. Run the line through the field of the meter in the usual manner, and the other side of the line goes to the lamp. Then for the shunt tap bring a wire from the centre line, or the 110-volt side, and you are all right by using a constant of (2). H. E. RYDER, Marlborough, Mass.

(Through an oversight, the following schedule of rates was omitted from Wrinkle A 8. It should have appeared on page 24.—EDITOR.

ALPENA ELECTRIC LIGHT COMPANY.

SCHEDULE OF METER RATES FOR LIGHTING.

No. of Lamps Installed.	Kind of Lamps.	Hours Daily Use.	Days in Month Used	Watts Used Per Lamp Hr.	Total Consumption Watts.	Rates Per 1000 Watts.	Approximate Monthly Bill.	If Paid On or Before the Tenth of Each Month			
								Discount Per 1000 Watts	Discount.	Net Rate.	NET BILL.
10	16	Less than 1	30	500		15 Cts.		2 Cts.		13 Cts.	
"	"	1	"	"	15000	14	$2 10	"	$ .30	12	$1.80
"	"	1½	"	"	22500	13	2 93	"	.45	11	2.48
"	"	2	"	"	30000	12	3.60	"	.60	10	3.00
"	"	2½	"	"	37500	11½	4.31	"	.75	9½	3.56
"	"	3	"	"	45000	11	4.95	"	90	9	4.05
"	"	3½	"	"	52500	10½	5.51	"	1.05	8½	4.46
"	"	4	"	"	60000	10	6.00	"	1.20	8	4.80
"	"	4½	"	"	67500	9½	6.41	"	1.35	7½	5.06
"	"	5	"	"	75000	9	6.75	"	1.50	7	5.25
"	"	5½	"	"	82500	8½	7.01	"	1.65	6½	5.36
"	"	6	"	"	90000	8	7.20	"	1.80	6	5.40
"	"	over 6	"	"		8		"		6	

[illegible]—12 Cents Per 1000 Watts. Discount 2 Cents If Paid on or Before the 10th of the Month.

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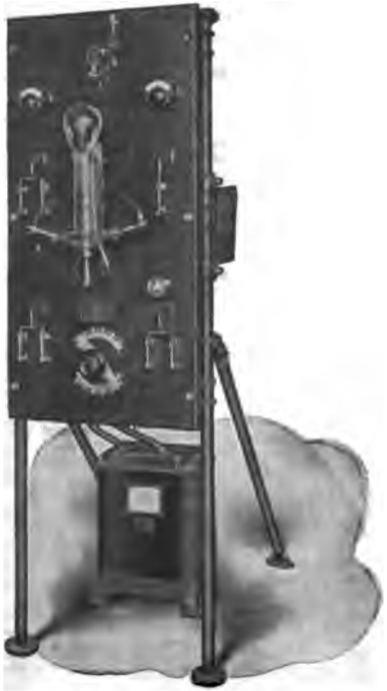

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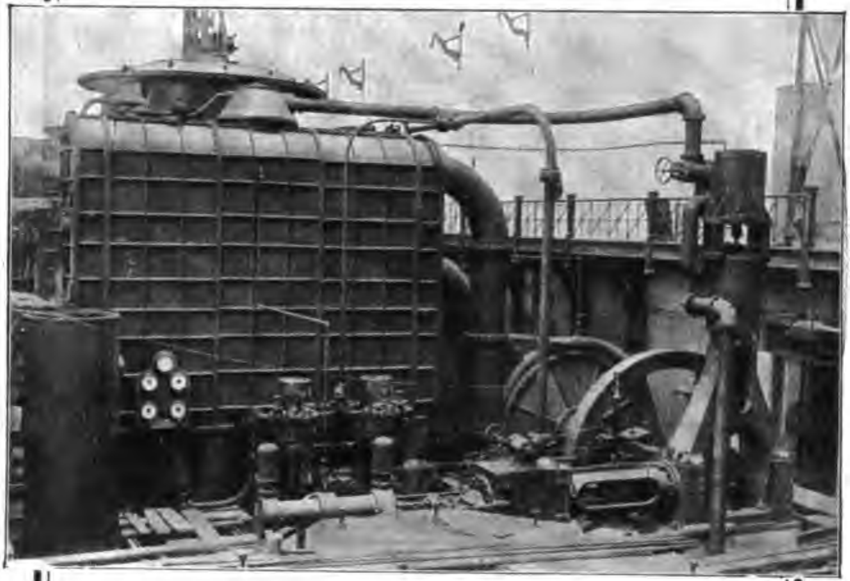

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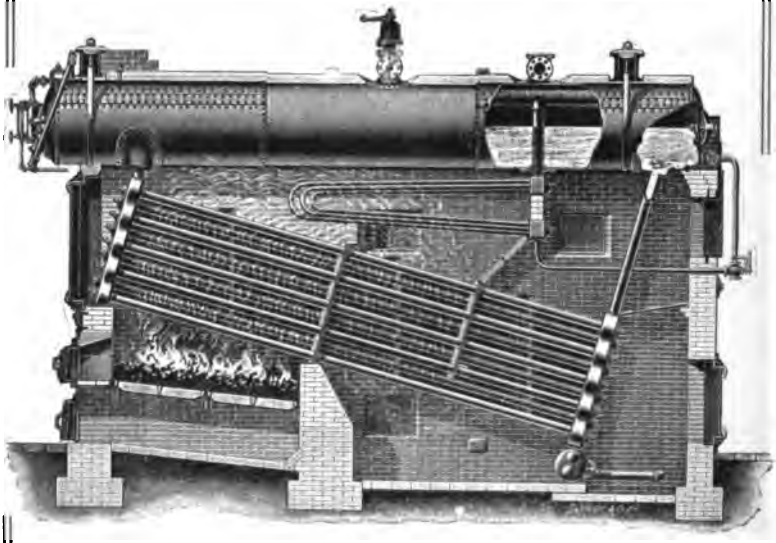

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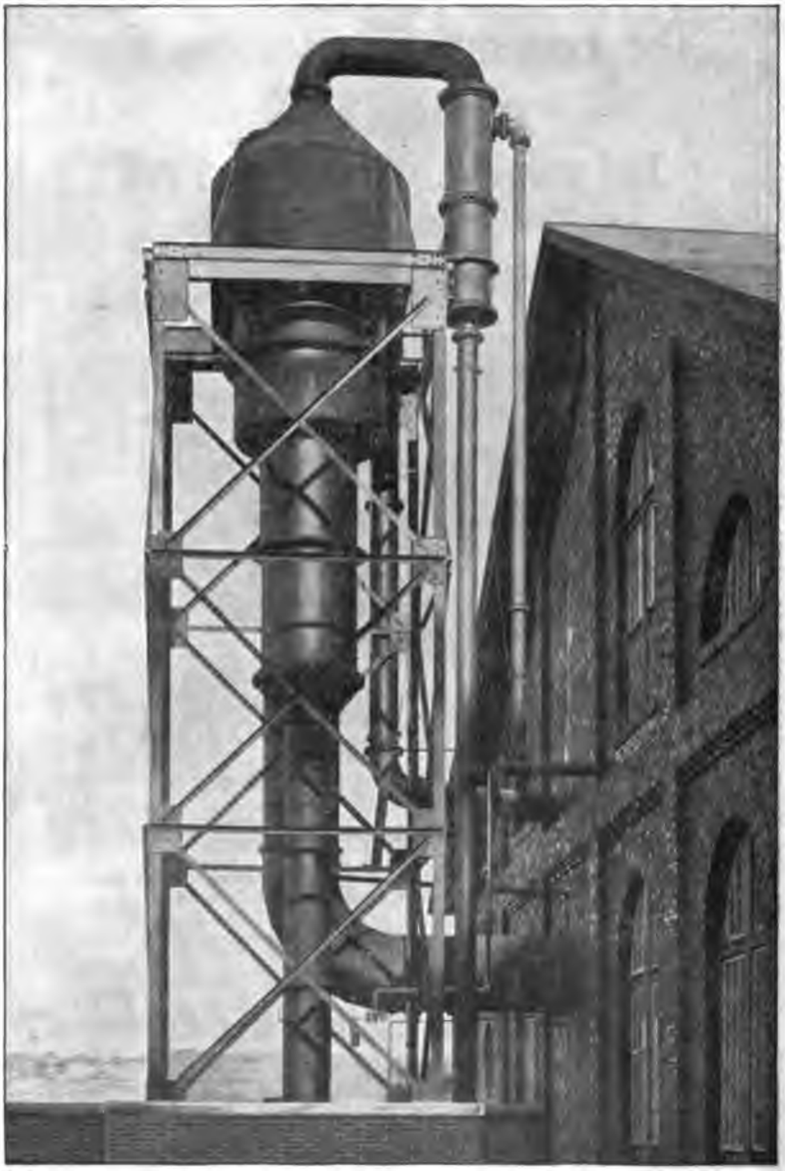

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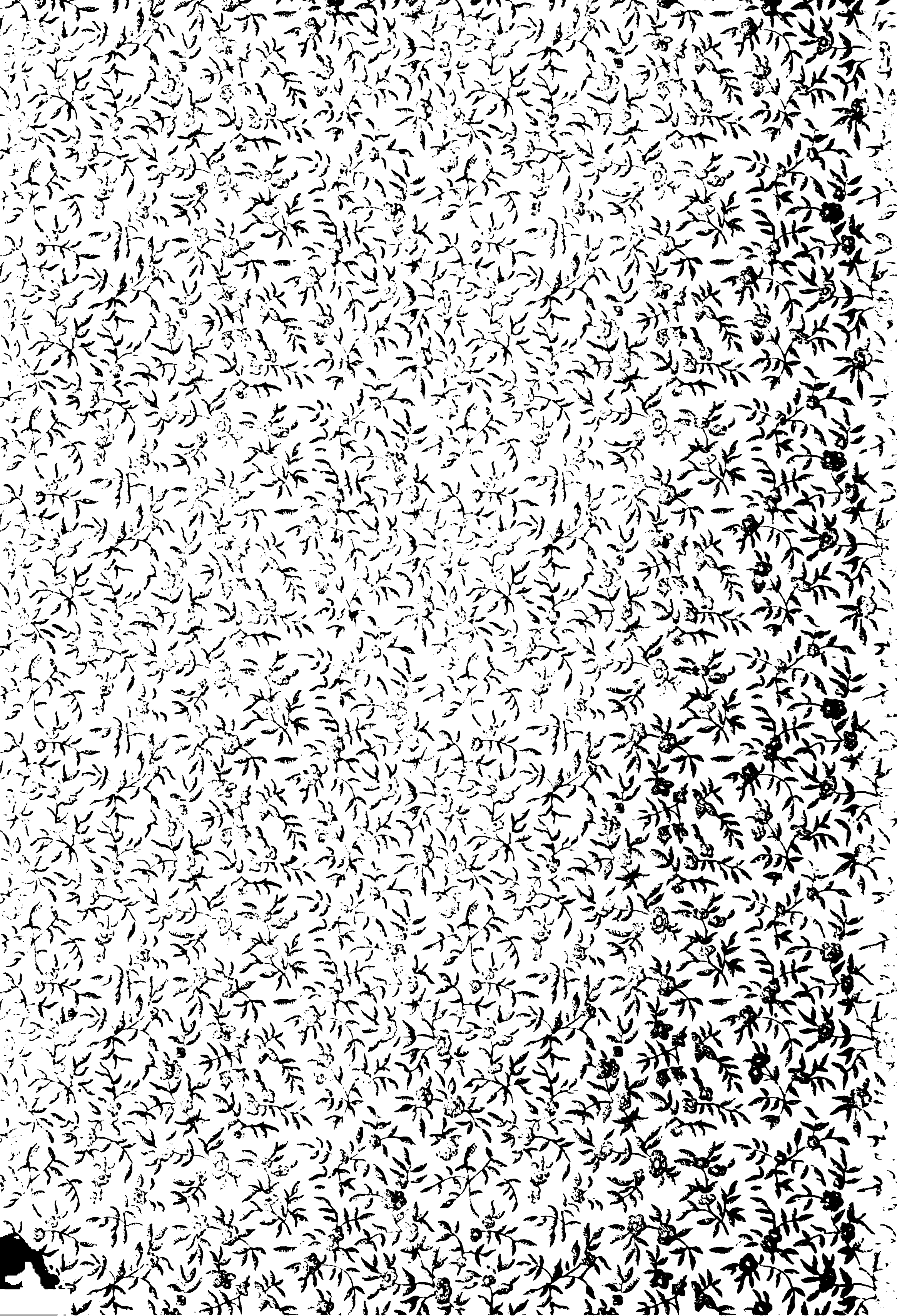

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